INSTRUCTION IN PHOTOGRAPHY

BY

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INSTRUCTOR IN PHOTOGRAPHY
AT THE
SCHOOL OF MILITARY ENGINEERING, CHATHAM

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PREFACE.

A SMALL edition of this Manual was originally prepared for private circulation amongst the officers and men of the corps of Royal Engineers. Many of it, however, got distributed beyond this circle, with the effect of creating such a large demand upon me for copies, that had I supplied them the numbers printed would long ago have been exhausted. Under these circumstances, I determined, with the sanction of the Inspector-General of Fortifications, to bring out an edition for the general public.

As the contents have been chiefly compiled from notes, names of persons who may be connected with processes are often omitted, not from intention, but from ignorance. As it is a work of a practical character, and not a history of the art, I trust that such omissions will not affect its value.

W. DE W. ABNEY,

CAPTAIN R.E.

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ERRATA.

On page 3, for

$$\overbrace{3AgI}^{\text{Iodide of Silver.}} = \overbrace{Ag_3I}^{\text{Subiodide of Silver.}} + \overbrace{I}^{\text{Iodine.}}$$

read—

$$\overbrace{3AgI}^{\text{Iodide of Silver.}} = \overbrace{Ag_3I}^{\text{Subiodide of Silver.}} + \overbrace{2I}^{\text{Iodine.}}$$

Also on page 3, for—

$$\overbrace{9AgI}^{\text{Iodide of Silver.}} = \overbrace{6Ag_3I}^{\text{Subiodide of Silver.}} + 6I$$

read—

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violet are active; most rapid change in a silver salt are situated about half-way between the two. With different salts of silver the range of actinic power varies slightly, inclining more or less to the red end of the spectrum. In some future day we may hope that some salt may be found to which even red rays will be actinic, thus giving a more truthful complexion to nature as represented in a photograph. It should be remembered, then, that white light only

INSTRUCTION IN PHOTOGRAPHY.

THE THEORY OF PHOTOGRAPHY.

Observation has shown that certain salts of silver undergo change in the presence of certain kinds of light. The change may be visible to the eye, as in the case of the darkening of chloride of silver, or may be ascertained by the behaviour of the salt when certain chemical agents are brought in contact with it, as in the case of iodide of silver in the wet collodion process. It is none the less true that the latter change is as real as the former, though it be invisible to our senses. It is found that lights of certain colours affect the silver salts, as well as pure white light, and that those of certain other colours refuse to cause that change. Those coloured rays of light which will effect a change (visible or invisible) are termed actinic, or chemical, rays; all others, non-actinic. When light is decomposed by a prism we have all the colours of the rainbow shown, and although they pass imperceptibly from one to the other, yet, for the sake of perspicuity, they have been divided into seven colours, which are called primary colours. They are red, orange, yellow, green, blue, indigo, and violet. Experiment has shown that lights of those colours which are included between the green and the violet are actinic, and that of these, those which produce the most rapid change in a silver salt are situated about half-way between the two. With different salts of silver the range of actinic power varies slightly, inclining more or less to the red end of the spectrum. In some future day we may hope that some salt may be found to which even red rays will be actinic, thus giving a more truthful complexion to nature as represented in a photograph. It should be remembered, then, that white light only

causes a chemical change in a silver salt, because, of its components, some are actinic. It is because the red and yellow rays are non-actinic that coloured glass of these hues is used in our developing rooms, the light admitted through such glass, if it be of good quality, being incapable of producing any *primary* change on the collodion film, which contains a silver salt. It must also be noted that when a ray of light is decomposed by a prism into its primary colours, and these be allowed to fall upon a film containing a sensitive salt, a change in the sensitive salt is produced beyond the place where the extreme violet ray is seen. These rays are called dark rays of the spectrum, and are usually denoted as ultra-violet. As these produce a change in the salt, they are likewise actinic rays.

Such is a short summary of the light which is valuable to photographers, and we shall now discuss the means by which the invisible changes that have taken place in the sensitive salts are made apparent and utilized.

The sensitive salts of silver which are usually employed in photography are, the iodide, the bromide, and the chloride of silver. There are others, which are rarely used, and to which we may refer further on. In order to illustrate the theory of the formation of a photographic image, the iodide will be taken as a type, the action of light on the other salts being similar.

Iodide of silver (Ag I) can be formed in two or more ways—by the action of a soluble iodide, or of iodine vapour upon metallic silver; or by the humid method. This last method is that employed for its formation in ordinary photography:—The soluble iodide of a metal, or metalloid, such as cadmium, ammonium, &c., is brought in contact with a solution of nitrate of silver; the iodine, having a strong affinity for the silver, forms iodide of silver, setting the nitric acid free, which in its turn combines with the metal originally in combination with the iodide. Chemically, it is expressed thus,—

$$\overbrace{CdI}^{\text{Iodide of Cadmium.}} + \overbrace{AgO, NO_5}^{\text{Nitrate of Silver.}} = \overbrace{AgI}^{\text{Iodide of Silver.}} + \overbrace{CdO, NO_5}^{\text{Nitrate of Cadmium.}}$$

Or, in new notation,—

$$[CdI_2 + 2AgNO_3 = 2AgI + Cd(NO_3)_2]^*$$

---

* The new notation will be denoted by placing the equation in brackets.

Plain collodion may be considered, for the purpose of illustrating the theory of photography, as an inactive body, exerting no influence whatever on the chemical reactions that take place, but merely as a vehicle used to retain certain chemical compounds in *situ*.

Further on we shall see that in the collodion are dissolved salts which contain bromine and iodine, and that this collodion is flowed over a glass plate and allowed to set. After setting, the film is immersed in a solution of nitrate of silver; consequently, as far as the iodide is concerned, the above reaction takes place. (In the above equation, if we were to substitute Br for I, the same would hold good, the decomposition being similar.) This film containing iodide is, whilst still moist, taken out of the bath and exposed to the action of light; if the rays are directed by a lens, they form an image; if uncontrolled, the chemical change takes place over the whole plate.

The chemical change that takes place in the iodide of silver by the light we have very good reason to believe to be the formation of a subiodide of silver. Thus,—

$$\overbrace{3AgI}^{\text{Iodide of Silver}} = \overbrace{Ag_3I}^{\text{Subiodide of Silver.}} + \overbrace{2I}^{\text{Iodine.}}$$

If no body which will absorb iodine be present this change will not take place, for if we thoroughly wash a plate on taking it out of the bath, and attempt to develop it, after exposure to light, no alteration in its aspect will be manifest. It is therefore evident that in wet photography the nitrate of silver plays an important part. The change that must take place is as follows:—

$$\overbrace{9AgI}^{\text{Iodide of Silver.}} = \overbrace{3\,6Ag_3I}^{\text{Subiodide of Silver.}} + 6I$$

The 6I comes in contact with $6AgO, NO_5$; and we have,—

$$\overbrace{6I}^{\text{Iodine.}} + \overbrace{6AgO,NO_5}^{\text{Nitrate of Silver.}} + \overbrace{6HO}^{\text{Iodide of Silver.}} = 5AgI + \overbrace{AgOIO_5}^{\text{Iodate of Silver.}} + \overbrace{6HONO_5}^{\text{Nitric Acid.}}$$

$$[6I + 6AgNO_3 + 3H_2O = 5AgI + AgIO_3 + 6HNO_3]$$

In dry plate photography the action of light is precisely the same; but the free nitrate of silver solution is replaced in this case by some body *which will combine with iodine.*

DEVELOPMENT.

As we have said before, the change to the state of subiodide is invisible or latent, and we needs must find some agent which will bring the chemical action to the cognizance of our senses. Pyrogallic acid is a chemical which is well known for its affinity for oxygen, as are the ferrous or protosalts of iron, the latter tending to form the ferric, or persalts, that are to combine with more oxygen. We will take the example of the latter when applied to the latent image. It is based on the assumption that the subiodide of silver has an affinity for metallic silver, and, consequently, causes the silver from the free nitrate solution to be deposited by the developer upon those parts acted upon by light. It would stand thus:—

Nitrate of Silver.	Protosulphate of Iron.	Silver Deposited on the Subiodide.	Persulphate of Iron.	Pernitrate of Iron.
$3(AgO,NO_5)$	$+ 6(FeO,SO_3)$	$= 3Ag$	$+ 2(Fe_2O_3 3SO_3)$	$+ Fe_2O_3,3NO_5$
$[3AgNO_3$	$+ 3FeSO_4$	$= 3Ag$	$+ Fe_2(SO_4)_3$	$+ Fe(NO_3)_3]$

A little consideration will show that if this action take place the image must be *on the surface of the film*, and not in it. Experience shows that such is the case. The theory of the reduction of bromide of silver by an alkali will be stated when the theory of dry plates is considered, when it will be seen that the image is *in* the film, and not *on* it.

ON THE ADDITION OF AN ACID TO THE DEVELOPER.

In the practical formulæ for developers it will be noticed that the addition of (acetic) acid is invariably included. If to a solution of protosulphate of iron (or pyrogallic acid) a solution of nitrate of silver be added, it will be found that there is an almost instantaneous deposit of metallic silver. In fact, this is one method of reducing silver from an old bath solution. Suppose a developer such as this were flowed over a plate which had free nitrate of silver on it, it would be found that an immediate precipitation of silver took place all over the film. The attraction of the subiodide of silver (adopting our theory of development) would be rendered void, owing to the rapidity of deposit.

If either of the solutions be acidified, the deposition would take place with greater regularity and less rapidity. If it were

sufficiently slow the subiodide would be able to attract all the particles of metallic silver as they were formed, and thus build up a metallic image. In practice the acid added is just sufficient to cause this gradual reduction of the silver. Heat increasing the rapidity of chemical action, it follows that in decidedly hot weather a larger quantity of acetic acid should be used than in cold.

It will also be noticed on page 18, that different strengths of iron for the developing solutions are given. The stronger the iron solution the greater chemical power it will have, and the more rapidly it will decompose the silver solution. As a consequence, with a strong solution, all parts of the picture acted upon by light will immediately become nuclei for the deposition of silver, and the deposit will be of more even density than if a weaker solution had been employed; for with the latter those parts most acted upon by the light—*i.e.*, which had been most thoroughly converted into subiodide—having the most attractive force, would draw the deposit of silver to them, and the image would be much more intense at those parts than where the light had less strongly acted. This, which is true in theory, has been verified by practice.

INTENSIFYING.

Any method of increasing the opacity of the developed image to the chemical rays, either by changing its colour or rendering the deposit thicker, is called "intensifying a negative." The agents used are called "intensifiers."

The chemical actions of intensifying will be divided into two groups: 1st, the action that takes place by increasing the thickness of the deposit; 2nd, by change of colour.

Either pyrogallic acid, or protosulphate of iron, may be employed with nitrate of silver to cause an increase of density by thickening the deposit of the metallic silver. The reactions here are analogous to those of development, excepting that the metallic silver is the attractive matter instead of the subiodide. Both these have the property of assisting the decomposition of the solution of the silver salt, as before stated. The silver must be reduced gradually to the metallic state, when it will be deposited on those parts on which silver has already been reduced by the action of the developer, in the ratio of their densities.

When we dip a piece of bright copper wire into a solution of

nitrate of silver, on withdrawal we find it coated with a deposit of silver. Chemically, we may denote the action thus:—

Copper.	Nitrate of Silver.	Silver.	Nitrate of Copper.
Cu +	AgO,NO_5 = Ag +		CuO,NO_5
[Cu +	$2AgNO_3$ = 2Ag +		$Cu(NO_3)_2$]

If, instead of these two metals, we have silver and a solution of chloride of gold ($Au\ Cl_3$), we should have,—

Silver.	Chloride of Gold.	Gold.	Chloride of Silver.
3Ag +	$AuCl_3$	= Au +	3AgCl

alike in old and new notation; in other words, gold displaces the silver, and produces a change in colour.

Any one acquainted with even the elements of chemistry will be aware that a solution of a silver salt added to other chemical bodies, such as bichromate of potash, permanganate of potash, &c., produces a precipitate of a varying colour; in the first case, a reddish one resulting.

It is found that by flooding a developed and fixed film with certain of these chemicals a corresponding change in colour takes place. In most cases a preliminary conversion of the metallic silver to the form of iodide facilitates this change. This is accomplished by flowing over the plate a solution of a soluble iodide and iodine.

To take another example of intensification by change of colour. If, after the conversion of a small layer of the fixed image into iodide, we flow over it or immerse it in permanganate of potash, we get binoxide of manganese deposited on the silver, thus,—

Silver.	Iodide of Silver.	Permanganate of Potash.	Oxide of Silver.	Iodide of Potassium.	Binoxide of Manganese.
3,Ag +	AgI	+ KO,Mn_2O_7 =	4AgO +	KI	+ $2MnO_2$
[3Ag +	AgI	+ $KMnO_4$ =	$2Ag_2O$ +	KI	+ MnO]

FIXING.

After the development of the latent image or picture formed upon the sensitive collodion film, the iodide and bromide of silver are left unaltered, and, probably, the subiodides and bromides.

Looking at the reverse side of the plate (that which does not bear the film), the green colour of the iodide and bromide of silver will be apparent.

Were this unaltered iodide and bromide of silver left in the film, a print taken from it on paper in the ordinary manner would be found to be *nearly* a blank, the iodide and bromide possessing almost as much power of preventing the passage of light as the reduced silver itself. Certain chemical solutions, however, are found to be capable of dissolving the iodide and bromide, leaving the metallic silver unchanged. These chemical solutions are termed "*fixing solutions*" or "*agents*," and the operation of dissolving out the iodide and bromide of silver is termed "*fixing* the image." These terms apply equally to those agents and operations in printing which render the image permanent. Here, however, chloride of silver is acted upon. Dismissing the chlorides of the alkalies and iodide of potassium (owing to their imperfections as fixing agents), the first solvent of iodide, bromide, or chloride of silver that is to be noticed is hyposulphite of soda (NaO, S_2O_2).

The chemical reaction of this salt upon the bromide being similar to that upon the iodide, the case of the latter alone will be considered.

Iodide of Silver.		Hyposulphite of Soda.		Double Hyposulphite of Silver and Soda.		Iodide of Sodium.
AgI	+	$3NaO,S_2O_2$	=	$AgO,2NaO,2S_2O_2$	+	NaI
$[2AgI$	+	$2Na_2S_2O_3$	=	$Ag_2Na_2(S_2O_3)$	+	$2NaI]$

The double salt is soluble in a solution of hyposulphite of soda; consequently the darkest shadows of the image will be rendered transparent through the removal of the iodide (and bromide) by the application of the latter in excess.

The only other fixing agent that is in general use is cyanide of potassium (KCy or K,C_2N). Its chemical reaction on the iodide and bromide of silver is similar to that of the hyposulphite of soda, a double cyanide of silver and potassium being formed which is soluble in a solution of cyanide of potassium.

The cyanide of potassium has also a slightly solvent power on finely-deposited metallic silver. If a test-tube be coated with a fine layer of metallic silver (as given for "Silvering Mirrors"), it will be found that a strong solution of cyanide of potassium will dissolve it completely after a short interval of time. Hence is apparent the need of using a weak solution of this fixing agent, and allowing it to remain on the plate as short a time as possible.

The cyanide of potassium is a *deadly* poison, and great caution should be exercised in working with it. Its fumes are deleterious to the system, and if the solution come in contact with a cut or sore place in the skin, festering is liable to occur. Should, by any accident, any of the solution be taken internally, a draught of iron developer taken immediately will render it innocuous. Similarly, the iron solution, applied to the cut or sore which has been in contact with the poison, will prevent bad results. If festers *do* occur through its use, an ointment made of lard and finely powdered protosulphate of iron will prevent a further spread of the mischief.

Most photographers recommend the hyposulphite, in preference to the cyanide, as a fixing agent, owing to the latter's poisonous character and liability to eat into the half-tones. The colour of the negative given by the latter, by reflected light, is whiter, but by transmitted light, browner, and, consequently, more non-actinic than if the former be used. For this reason, and also on account of the much diminished washing that is required to free the film from the traces of the fixing solution, the cyanide is here recommended as the agent to be generally used. If ordinary precautions are taken, it need not prove hurtful to the operator through inhalation or otherwise; and if the film be washed *immediately* after the iodide of silver is dissolved out, there need be no fear of an attack on the half-tones. Hyposulphite of soda is to be avoided, on account of the mischief which even one drop of its solution causes to the bath.

Great care should be taken that no acid come in contact with the cyanide solution, as it is decomposed, and hydrocyanic acid vapour (prussic acid) is given off. The vapour is almost more dangerous than the liquid solution.

WET PLATE FORMULÆ.

PLATE CLEANING.

In order to make a plate chemically clean, some body must be found which will free it from mechanical dirt—such as dust—and also from grease. Spirits of wine has the property of holding most kinds of the latter in solution, hence it generally forms a portion of a plate-cleaning formula. Any alkali will turn grease into soap, rendering it soluble in water; hence this is

often recommended as an addition. To free a plate from mechanical dirt, some powder of an impalpable description is found to answer well when made up in a paste, hence the employment of tripoli powder and rouge. Common whitening has the property of absorbing grease when dry; hence a cream of this made up with water is sometimes applied to a plate, allowed to dry, and rubbed off in that state. The usual formulæ for a plate-cleaning solution is tripoli powder; spirits of wine sufficient to form a thin cream; liquor ammonia, about ten drops to each ounce of the cream. Rouge may be substituted for the tripoli powder. Unless it be of the finest nature, it is liable to cause scratches. It has also the disadvantage of injuring the bath if any be carried into it by the plate.

COLLODION.

Collodion is gun-cotton dissolved in a mixture, varying in proportions, of alcohol and sulphuric ether. Its qualities vary with the kind of gun-cotton (*i.e.*, pyroxyline), and with the proportions of the solvents used.

Pyroxyline is cotton or fibre (cellulose or lignine) which has been altered in chemical composition by treatment with a mixture of nitric and sulphuric acids, or with chemicals equivalent to them. The change that takes place is due to the combination of peroxide of nitrogen with the cellulose or lignine. The chemical action may be symbolized as follows:—

$$\overbrace{C_{36},H_{30},O_{30}}^{\text{Cotton.}} + \overbrace{9HO,NO_5}^{\text{Nitric Acid.}} + \overbrace{HO,SO_3}^{\text{Sulphuric Acid.}}$$

$$= \overbrace{C_{36}H_{24}(6NO_4)O_{30}}^{\text{Pyroxyline.}} + \overbrace{HO,SO_3}^{\text{Sulphuric Acid.}} + \overbrace{9HO}^{\text{Water.}}$$

$$[C_6H_{10}O_5 + 2HNO_3 + H_2SO_4 = C_6H_8(NO_2)_2O_5 + 2H_2O + H_2SO_4]$$

It will be noticed that the sulphuric acid remains unchanged. Its employment is owing to its affinity for water. Hydrogen from the cotton is abstracted, and combines with the oxygen liberated from the nitric acid. This forms the water which the sulphuric acid absorbs. The formula shows that six equivalents of hydrogen are displaced by six equivalents of nitric peroxide. When nine equivalents are displaced we have the true explosive gun-cotton. The difference in the temperature of the acids, &c., determines whether tri-nitro or di-nitro (pyroxyline) cellulose will be formed.

The manufacture of pyroxyline is one of considerable difficulty, though not at all out of the range of ordinary skill. For amateurs the second process will, it is believed, be the most useful. The general directions given are those found in Hardwich's Photographic Chemistry.

1st Process:—Take sulphuric acid 1·845... 18 fluid ounces.
Nitric acid 1·457 ... 6 ,, ,,
Water ... ... $4\frac{3}{4}$,, ,,

The water is first poured into a strong glazed porcelain basin, the nitric acid next added, and lastly, the sulphuric acid. The mixture is well stirred with a glass rod. The temperature will now be found to be somewhere about 190°. It must be allowed to cool to 150°, and this temperature must be maintained on a water-bath. A dozen balls of cotton wool, weighing about thirty grains (which have previously been well washed and dried), should now be immersed separately in the fluid with the aid of a glass spatula. Each ball should be pressed separately against the side of the basin, till it is evident that the acids have soaked into the fibre. Care must be taken that each one is immersed at once. Failing this, a different chemical combination takes place, and nitrous fumes are given off, and the success of the operation will be vitiated. Immersing the dozen balls will take about two minutes. The basin should after this be covered up for about ten minutes.* At the expiration of this time the whole of the cotton should be taken up between two glass spatulas, and against the sides of the clean porcelain capsule as much of the acids as possible should be squeezed out. The cotton should then be dashed into a large quantity of water, and washed in running or frequent changes of water for twenty-four hours. Finally, when it shows no acid reaction to blue litmus paper, it is dried in the sun or on a water-bath.

2nd Process:—Sulphuric acid of commerce 6 fluid ounces.
Dried nitrate of potash ... $3\frac{1}{2}$ ounces (Av.)
Water ... ... 1 fluid ounce.
Best cotton wool... ... 60 grains.

Mix the acid and water in a porcelain vessel, then add the nitrate (which has previously been dried on a metal plate to about 250°, and then pulverized) by degrees, stirring with a

* This prevents the access of the air to the fluid, and prevents the absorption of oxygen, and consequent formation of the nitrous fumes.

glass rod until all lumps disappear, and a transparent viscous fluid is obtained. This will occupy several minutes.

The whole of the cotton wool must now be separated into balls the size of a walnut, and immersed as stated in the first process, care being taken that the temperature is kept up to 150°. The cotton is then left ten minutes, and washed as before. Mr. Hardwich states that the chances of failure in this process "are very slight, if the sulphuric acid be sufficiently strong, and the sample of nitrate not too much contaminated with chloride of potassium." If failure occur through the cotton dissolving in the acid, a drachm less water must be used.

In both processes the operation may be conjectured to be successful if the cotton tear easily in the hand, and if the original lumps cannot be easily separated. Should nothing but fragments of the lumps be detected, it is probable (if the acids used have been of the strength given above) the temperature has been allowed to fall. If dried, the pyroxyline should, when pulled, break up into little bits, and should not resemble the original cotton in texture.

The weight of good pyroxyline should be greater than the original cotton by about 25 per cent.

If the acids used are too strong, the pyroxyline will be much heavier than this per-centage, and will make a thick glutinous collodion; whereas, if the acids have been too diluted, it will probably weigh less than the original cotton, and will yield a collodion adhering firmly to the plate, and giving negatives of too great softness; any small particles of dust that may fall on the glass will form transparent marks. The formula given steers between the two extremes.

The following are formulæ which experience has shown are good for plain collodion:—

No. 1.	Pyroxyline	55 grains
	Alcohol ·820	4½ ounces
	Ether ·725	5½ ,,
No. 2.	Pyroxyline	55 grains
	Alcohol ·820	5 ounces
	Ether ·725	5 ,,

No. 1 is suitable for winter; No. 2 for summer work. The more alcohol in proportion to the ether that is used the slower the collodion sets. A limit, however, to the proportions to be

used, arises from the fact that if the alcohol be added in excess the film becomes streaky, whilst if the excess be of ether, the film becomes too contractile, and has a tendency to split on drying. In mixing the collodion the alcohol should be added first to the pyroxyline, as by so doing its dissolution is aided. It must also be remembered that the quantity of pyroxyline given above is dependent on its quality, whether it tend to form a gelatinous or limpid collodion. In the former case, less must be used; whilst in the latter more may be added.

Iodides and bromides of metals are added to the plain collodion to render it capable of forming a fine layer of iodide and bromide of silver in the negative bath. If iodides are used alone, a dense image is formed with but little detail in the shadows, and a long exposure is necessary in the camera. Bromides used alone give a faint image, but full of detail, and the time required to impress a latent image on the sensitized film is much shorter than when iodides alone are employed. It is thus evident that a judicious mixture of the two will give a film which, when sensitized, has the delicacy of the bromide, and the density of the iodide, whilst the time of exposure will be somewhat between that required for the two separately.

The iodides and bromides of potassium, ammonium, zinc, and cadmium, have all been tried by various makers. The first and third in the list have, for certain reasons, been discarded, and the other two form the staple iodizers and bromizers employed.

The following is a list of the combining proportions of iodine and bromine in the iodides and bromides of the metals:—

In 10 grains of	iodide of potassium	7·636 grains	iodine
,, ,,	bromide ,,	6·639 ,,	bromine
,, ,,	iodide of cadmium	6·923 ,,	iodine
,, ,,	bromide ,,	5·882 ,,	bromine
,, ,,	iodide of ammonium	9·403 ,,	iodine
,, ,,	bromide ,,	8·163 ,,	bromine
,, ,,	iodide magnesium	9·137 ,,	iodine
,, ,,	bromide ,,	8·586 ,,	bromine
,, ,,	iodide of zinc	7·95 ,,	iodine
,, ,,	bromide ,,	7·1 ,,	bromine

A standard iodizing solution having been arrived at by experiment with any of the iodizers and bromizers given above, the value of the others may be determined.

The following is a standard that has been found to answer well:—

No. 1.—* Iodide of cadmium ...	...	4½ grains
Bromide of cadmium	...	2 ,,
Plain collodion ...	...	1 ounce

On referring to the table the following modifications arise in the formula where alkaline salts are used. We shall have then for one formula:—

No. 2.—Iodide of ammonium	...	3⅓ grains
Bromide of cadmium	...	2 ,,
Plain collodion ...	...	1 ounce
No. 3.—Iodide of cadmium ...	...	2¼ grains
Iodide of ammonium	...	1⅔ ,,
Plain collodion ...	...	1 ounce
No. 4.—Iodide of ammonium	...	3 grains
Iodide of cadmium ...	...	½ grain
Bromide of ammonium	...	1⅔ grains
Plain collodion ...	...	1 ounce

No. 1 should be mixed at least six months before use; it then gives a delicate image and fine detail.

No. 2 should be mixed two months before use, and answers well for landscapes.

No. 3 should be prepared four months before use, and is good for portraiture.

No. 4 may be used after mixing two or three days, and is a good "general purpose" collodion.

The following general rules may be given for modifying the tendencies of collodion.

1. If a *decrease* of contrast and more detail be required, add bromide.

2. If violent contrasts are wanted, the iodides should be increased and the bromides diminished. One quarter-grain of bromide to the ounce of collodion is found to be sufficient to secure cleanness in the shadows, and all but this quantity may be taken away if necessary.

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* Cadmium renders collodion glutinous on first iodizing. When kept, it becomes more limpid. Ammonium fits collodion for more immediate use, as it does not cause it to become glutinous, even on first iodizing.

Dr. Liesegang has introduced a new form of pyroxyline called papyroxyline. It is prepared from paper instead of cotton, and its value for giving tough films is great. Four grains of papyroxyline are equivalent to five of pyroxyline. A judicious mixture of the two in the solvents gives highly satisfactory results.

Collodion should be stored in a dry and cool place; if otherwise, the ether is apt to become decomposed, which, in its turn, decomposes the pyroxyline. Collodion made with pure spirit and neutral cotton will be colourless after iodizing, but if made with impure solvents it will become first dark, and may then return to its original colour. Should the pyroxyline be acid (not sufficiently washed after preparation), the collodion will become sherry-coloured almost immediately, but will not keep in good working condition for long.

Methylated alcohol and ether are often employed by manufacturers as solvents. Experience teaches that, though harmless for a short time, they contaminate the nitrate of silver bath if used for any length of time. It is noticeable that a collodion made with pure solvents frequently refuses to work in a bath in which adulterated solvents are found.

Collodion should be always labelled and dated after manufacture and iodizing. This precaution will be found of the greatest use in selecting a specimen suitable for any particular purpose. The following is a specimen of a label:—

PLAIN COLLODION MADE 15th JULY, 1870.

Pyroxyline (prepared 1st of June, 1870) ...	3 grains
Papyroxyline	2 ,,
Sulphuric ether (pure)	½ ounce
Alcohol ·820	½ ,,

Iodized 4th August, 1870.

Iodide of ammonium	2½ grains
Iodide of cadmium	2 ,,
Bromide of cadmium	2 ,,

Any bottle of collodion thus labelled will tell its own tale, and be a guide for future manufacture. With the collodion of commerce all you can do in labelling is to give its date of iodizing; even this will be found very useful.

When the iodized collodion is of a pale straw colour, it is in its most sensitive condition. After it assumes the dark brown sherry colour, from the liberation of iodine and bromine, it becomes less sensitive, and is more apt to give harsh pictures.

When collodion is prepared, it should be tested before iodizing. First, coat a plate, and mark if it dry with any opalescence. Next, test the toughness of the film, and see if it be powdery, or if it come away in strips to the touch of the finger. When it is iodized it should be tried by taking two or three negatives, the behaviour of the films being carefully noted. It is useful to have a sample of other good collodion at hand to compare it with. If the two halves of a stereoscopic plate be coated with the two collodions respectively, and the sensitized films be exposed simultaneously, their relative sensitiveness and densities may be readily determined, and the results should be noted for future guidance. Any defect or peculiarity in the collodion should, of course, be noted and corrected.

Collodion which yields a thick creamy film gives a "plucky" image, whilst a limpid collodion gives one thin and transparent. This latter collodion may be improved by adding a grain or two of pyroxyline to each ounce. Should this defect arise from the use of alcohol and ether too anhydrous, it may be rectified by the addition of a drop or two of water to each ounce of collodion.

It will be found advantageous at times to mix the collodions prepared by different formulæ; thus, a collodion yielding great intensity of image should be mixed for general purposes with one which is deficient in this quality. This remark applies not only to home-made, but also to commercially supplied, collodions.

When testing the iodized collodion, should the unsensitized film dry opaque, the sample must be rejected, as it has decomposed, the pyroxyline having somewhat returned to its original condition of cotton.

Should the film after sensitizing appear like watered silk, then the collodion is too alcoholic, or else over-iodized. The probable cure for this is the addition of a drachm to the ounce of plain collodion prepared according to formula 1, page 11. Should the defect arise solely from the collodion being too alcoholic, it is probable that letting the film dry more thoroughly before sensitizing will effect a cure. If collodion be under-iodized, the developed image will be poor and flat, independently of impurities that may occur in the negative bath.

If the film, on drying, show "crape markings," the plain

collodion has been prepared with solvents of too great a specific gravity—*i.e.*, with too much water in their composition. To remedy this defect, an iodized collodion formed of absolute ether and alcohol should be added till the markings disappear.

Should the collodion, on setting, prove of a horny repellent nature, the defect may be cured by shaking it up with a small quantity of carbonate of soda, and decanting the supernatant liquid from the residue. A drop or two of water to the ounce will frequently answer the same purpose.

It has been stated that if the collodion prove too limpid, a grain or two extra of cotton to the ounce should be added. Collodion that has been iodized a long time often has this defect.

If collodion be made up with absolute alcohol and ether and the above amount of iodides and bromides, it will be found that the plate has the appearance of being stained with opaque streaks, especially at the corner of the plate from which the collodion was poured off, where, consequently, it was least set. To remedy this it is a good plan to add water to half the amount of collodion, till it appears on the withdrawal of the plate from the bath to have the appearance of crape, then to add the remaining half to that portion which was watered. On trying a plate it will be found that the film has lost the streaks, and is more dense than before. On the quality of the pyroxyline depends a good deal the amount of water that can be added.

THE SENSITIZING BATH.

The following formula may be used for an ordinary negative bath :—

*Recrystallized nitrate of silver	40 grains.
Distilled water	1 ounce
Iodide of potassium†	$\frac{1}{8}$ grains

Take a quarter of the quantity of water that is to be used, and dissolve the nitrate of silver in it; then add the iodide of potassium or other alkaline iodide. It will produce an emulsion of iodide of silver, which will be partially re-dissolved on agitation.

* A larger proportion of nitrate of silver is inadvisable for most purposes, whilst a smaller would give an image wanting in "pluck." If *fused* nitrate of silver be used, only thirty-five grains are necessary.

† Some prefer not to add any iodide to the bath, but to allow it to become saturated by work. If a plate be moved about continuously in a bath made minus the iodide, there need be no fear of pinholes.

Next add the remaining quantity of water. This will cause a re-precipitation of the iodide of silver. After filtration the bath solution should be tested for acidity or alkalinity. Blue litmus paper should only redden slightly after a minute's immersion. Should the red colour be produced immediately, a little carbonate of soda should be added, and the bath acidified with a few drops of a solution of nitric acid (1 drop of nitric acid to 12 drops of water.) Acetic acid is sometimes recommended for acidifying the bath. If it be used, acetate of silver is formed, which is injurious to sensitiveness and cleanliness of work. Should the test-paper refuse to redden, the nitric acid solution should be added. As a rule, if recrystallized nitrate of silver be used the bath will require the addition of neither alkali nor acid.

In the formula above distilled water is given. Doubtless, if procurable, it is the best to use, but it is by no means absolutely essential. Almost any water can be rendered available by a little attention to chemical considerations. (See last chapter.)

Nitrate of silver in solution will dissolve up a certain amount of iodide of silver, the quantity depending upon the strength of the silver solution, and on the temperature. If the bath were not saturated with the iodide of silver, on the immersion of a collodion film, the iodide of silver formed in the film would be dissolved out, partially or wholly, according to the time of immersion. In the former case transparent pinholes would be the result, and in the latter the film would be absolutely insensitive and transparent.*

Before taking a bath solution (or *bath*, as it will be hereafter called, for brevity) into general use it should be tested. This is best done by immersing in it a plate coated with collodion. When fully sensitized the plate should be placed in the dark slide, and then, for a second, *half* the plate exposed to white light. It should then be developed. A trace of fog on the part on which the light had not acted will denote that a slight addition of nitric acid is required, or that an organic or other foreign substance is present. The latter case will be treated of shortly. Should the plate, on withdrawal from the bath, show signs of countless small excrescences, it is probable that the latter is over-iodized. These small excrescences, after development, will be found, on fixing, to entirely wash away (the iodide being formed *on* and not *in* the film), leaving round transparent spots on that

* See foot-note ante for exception to this rule.

part of the film which had been exposed to the action of the light. The transparent spots or pinholes are caused by the interception of the light from the iodide of silver in the film, by the iodide deposited from the bath solution. In this case an ounce of bath solution should be added to an ounce of water. The nitrate of silver solution becoming weaker by this addition, an emulsion of iodide of silver will take place. This should be filtered out, and enough crystals of nitrate of silver added to bring the bath back to its proper strength. If the plate, after fixing, shows signs of pinholes without the excrescences being previously visible, the bath is under-iodized. In this case more iodide of potassium should be added.

DEVELOPERS FOR WET PLATES.

A developer (in photographic technicology) is any body which causes the invisible image formed by light on any metallic salt to become visible.

Developers may be divided into two great subdivisions, iron and pyrogallic acid.

Pyrogallic acid developers are now rarely used since it was discovered that protosulphate of iron was the better reducing agent. When iodized collodion is employed without a bromide in solution, pyrogallic acid may still be used. It gives a very dense image, and is found useful for copying purposes, though a much longer exposure of the film to the action of light is required than would be necessary with the sulphate of iron.

The usual formula for a pyrogallic acid developer is as follows:—

Pyrogallic acid	1 grain
Glacial acetic acid	20 minims
Alcohol	*quant. suf.*
Water	1 ounce.

Since iron developers have been introduced there have been many modifications in the formulæ used. The following will be found of the greatest utility:—

No. 1.—Protosulphate of iron	10 grains
Glacial acetic acid	15 to 20 minims
Alcohol	*quant. suf.*
Water	1 ounce.

No. 2.—Protosulphate of iron	... ...	30 grains
Glacial acetic acid	... ...	15 to 20 minims
Alcohol	... ...	*quant. suf.*
Water	... ...	1 ounce.

No. 3.—Protosulphate of iron	... ...	50 grains
Glacial acetic acid	... ...	20 minims
Alcohol	... ...	*quant. suf.*
Water	... ...	1 ounce.

The action of the different strengths of developers has been pointed out in page 5, from which it will be gathered that in weakly lighted views without sunshine No. 1 would be used; in moderately bright light, No. 2; and in very bright light, or where the contrasts between the bright lights and shadows are very marked (as in most interiors), No. 3 should be used to prevent what when in a print would seem to be an unnatural harshness of blacks and whites.

With a new bath, containing little or no alcohol, these developers may be employed without the addition of any alcohol. After the bath has been worked for some time it gets impregnated with the collodion solvents, and then the alcohol, *quant. suf.*, must be added to cause the developer to flow without greasiness.

It may happen that the acetic acid is weaker than the glacial quality. If sufficient of the weaker kind have not been added, a scum forming on the surface of the iron solution during development will point out the defect, when more acetic acid must be added till the developer works cleanly. Should the deep shadows of the picture tend to fog, the addition of two or three drops extra of the acid will keep them bright, if the bath be not in fault.

The addition of different organic substances to the developer has been proposed by various photographers. The following are most to be recommended:—

No. 4.—Protosulphate of iron	... ...	20 grains
Glacial acetic acid	... ...	18 minims
Lump sugar	...	10 grains
Alcohol... ...	... ...	*quant. suf.*
Water	... ...	1 ounce.

No. 5.—Protosulphate of iron ...	...	20 grains
Glacial acetic acid ...	...	10 minims
Gelatine*	...	1 grain
Alcohol...	...	*quant. suf.*
Water	...	1 ounce.

The addition of these "organifiers," as they are popularly termed, have an effect on the deposit of silver. It becomes more granular, owing to the slowness of the deposition, and is of a different colour. The sugar is found not to necessitate a longer exposure than if the ordinary developer be used; but the addition of the gelatine requires the action of light to be considerably prolonged to yield equivalent detail. Great density in a negative is acquired by all these organifiers, generally at the expense of the half-tones. They are not, as a rule, to be recommended, excepting for winter work, for copying plans, or for producing great contrasts in a landscape.

A good ordinary developer for general use, called "Wothly's Developer," is as follows:—

A perfectly saturated solution of the protosulphate of iron in water is prepared by adding six ounces of the iron salt to a pint of water.

No. 6.—Saturated solution of protosulphate of iron .		2 ounces
Glacial acetic acid		$\frac{1}{4}$ ounce
Alcohol		1 ,,
Water		16 ounces.

This developer keeps well, though it, like other solutions, loses its power after long mixing.

In all cases the protosulphate of iron will, after a certain time, absorb oxygen from the atmosphere, and become a persulphate.† As persulphate of iron will absorb no more oxygen, it is evident that its developing powers are lost, and, in fact, it is found that it acts as a retarder. The change in the salt of iron is shown by a red, rusty coloration of the developer. This colour may become visible in hot weather, two or three days after the solutions are mixed; in colder weather, a longer time elapses before the formation of the persulphate. A little persulphate in the

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* The gelatine should be first swelled up by cold water. Afterwards it should be dissolved by heat, and then the acetic acid added to it.

† $6(Fe\,O, SO_3) + 2O = 2(Fe_2O_3, 3\,SO_3) + 2\,Fe\,O.$

solution tends to keep the shadows bright, acting somewhat similarly to the acetic acid.

In time the *crystals* of the protosulphate of iron will decompose slightly, a yellowish powder forming on their faces. This is due to the formation of an oxide of iron, which is insoluble. Allowance should be made in weight for this.

The double sulphate of iron and ammonia has been employed as a developing agent with great success. It gives great delicacy to the image, and has the property of keeping an unlimited time in solution without change.

No. 7.—Ammonio-sulphate of iron	25 grains
Glacial acetic acid	25 minims
Water	1 ounce
Alcohol	*quant. suf.*

Formic acid is not a developing agent *per se*, but it seems, by experiment, to have the power of continuing the action of light on a sensitive film. Advantage has been taken (apparently unawares) of this property to add it to an iron developer.

No. 8.—Protosulphate of iron	30 grains
Glacial acetic acid	20 minims
Formic acid	10 ,,
Water	1 ounce
Alcohol	*quant. suf.*

The special qualities of this developer are, that short exposure is required, and detail in the shadows is brought out.

The organic, the ammonio-sulphate, and formic acid developers may have the strength of the iron salt increased or diminished, similarly to the ordinary iron developers, by paying attention to the quantities of acetic acid added.

Another developer, as given by Mr. Rangel, of Penmaen Mawr, is well worthy notice:—

Protosulphate of iron ...	2 ounces
Water	10 ,,

Add to this, when dissolved,—

Ammonia (·880)	$1\frac{1}{2}$ to $1\frac{3}{4}$ drachms.

This will deposit the iron as protoxide. Add to the solution containing the precipitate,—

Glacial acetic acid	2 ounces.

This will redissolve the iron protoxide. Two to three ounces of this to be added to one pint of water for ordinary use. It may be used of greater strength if requisite.

This developer works very slowly, but very evenly, and is a very useful formula for beginners to work with.

It will be found advantageous to dissolve the protosulphate of iron in the water previous to the addition of the acetic acid or alcohol. As a rule, a red deposit of iron will appear; this may be filtered out after the addition of the acetic acid.

INTENSIFIERS.

The following are formulæ for "density" intensifiers:—

No. 1.—Pyrogallic acid	... ...	2 grains
Citric acid	... ...	2 to 4 grains
Water	... ...	1 ounce
No. 2.—Protosulphate of iron	... ...	5 grains
Citric acid	... ...	10 ,,
Water	... ...	1 ounce

No. 3.—An ordinary developer without alcohol.

Nos. 2 and 3 are usually employed in portraiture, and they are unusually efficacious in bringing out detail.

No. 1 brings up density more quickly than Nos. 2 and 3, and acts well for a properly exposed picture. Any of the above may be used either before or after fixing. To each a few drops of a ten-grain solution of nitrate of silver should be added immediately before it is applied to the negative.

The next formula is for changing the metallic silver, after the image is fixed, to iodide of silver.

No. 4.—Iodine	... ...	1 grain
*Iodide of potassium	... ...	2 grains
Water	... ...	1 ounce

After this solution has been applied to the film, any of the following may be used to cause the formation of a non-actinic colour.

Permanganate of potash intensifier (Mr. Wharton Simpson's).

No. 5.—Permanganate of potash	... ...	18 grains
Water	... ...	1 ounce

* Iodine is very sparingly soluble in water; if iodide of potassium be added, complete solution takes place.

This is most easily applied by immersing the plate in a flat dish till it appears of a yellowish colour throughout. The permanganate of potash is decomposed on coming in contact with the iodide of silver, and parts with its oxygen, which combines with the silver; at the same time the insoluble binoxide of manganese is precipitated on the image.

No. 6.—Persulphate of uranium ...	...	1 drachm
Ferridcyanide of potassium	...	1 ,,
Chloride of gold	...	1 grain
Water	...	20 ounces

The colour of the deposit by this intensifier is changed to a rich chocolate brown. The solution should be used in a flat dish.

No. 7.—Hydrochloric acid ...	...	1 drachm
Saturated solution of bichromate of potash	...	$1\frac{1}{2}$,,
Water	...	1 ounce

This gives a lemon colour, which, after further treatment, yields one more approaching orange.

No. 8.—*Bichloride of mercury ...	...	20 grains
Bichloride of ammonium ...	...	20 ,,
Water	...	1 ounce
No. 9.—†Bichloride of mercury ...	...	2 grains
Water	...	18 ounces

Add a solution (10 grains to 1 ounce of water) of iodide of potassium till the red precipitate formed by its addition is on the point of becoming permanent.

With Nos. 7 and 8 the following solutions may be used, should sufficient density (as would be the case in copying plans) not be obtained.

No. 10.—Hydro-sulphide of ammonium ...	...	1 ounce
Water	...	30 ounces

Or,

No. 11.—Cyanide of potassium ...	...	5 grains
Water	...	1 ounce

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* Bichloride of mercury is only sparingly soluble in water; the addition of chloride of ammonium causes it to dissolve readily.

† In this case No. 4 formula need not be used, as the iodide of potassium in this plays its part

Nitrate of silver to be added till a permanent precipitate is obtained. This last solution should stand a night before it is used.

No. 12.—Ammonia	1 drachm
Water	1 ounce

There is but little choice between Nos. 5, 6, and 7; they are mostly suited to landscape negatives. Nos. 8 and 9 are used with good effect for pictures in which great density is required, or strong contrasts, particularly if followed by No. 10, 11, or 12; in both cases the high lights will be of a dense black or olive tint. From Nos. 4 to 10 all the solutions should be used after the image has been fixed.

When the sensitive film has been exposed and developed sufficiently to bring out the details of the image, and there is no tendency for the shadows to be "fogged" or veiled, and in the case of slightly under-exposed pictures, intensification, by increase of density, should take place *before* fixing; if there has been over-exposure, *after* fixing. With an over-exposed picture, before fixing, an intensifier acts like a developer, and would cause fog; in most cases it is wise before using the intensifier, after fixing, to flood the plate with No. 4.

In intensifying after fixing, it may happen that the shadows get slightly stained by a deposit of silver. The following will generally prove efficacious in removing such a stain:—

Glacial acetic acid	1 ounce
Water	1 ,,

VARNISHES.

Varnish is used to give protection to the delicate collodion film. It is simply a resin or resins dissolved in spirit of some description. When the solvent evaporates spontaneously, or by aid of heat, a thin layer of these resins is left, which gives the necessary hardness of film to a negative for printing operations.

As a rule, it may be stated that the more colourless, the more suitable is a varnish for negatives.

The solvents used for varnishes are almost invariably alcoholic. It is important that the specific gravity of the solvent should be greater than that of the alcohol of the collodion, as, were it otherwise, the image would be apt to be dissolved away with a portion of the film.

The preparation and constituents of most varnishes are trade secrets, and it is advisable to purchase, in preference to manufacturing, them. Newman's diamond, Thomas's Berlin, and Rouch's varnish, are all good articles to be recommended. Schœné varnish is unsatisfactory; it does not set hard, and is apt to stick to the superimposed paper if the temperature be high. One formula for the preparation of varnish is given which has proved efficient—

Alcohol	16 ounces
*Unbleached lac	2 ,,
Sandarach	2 ,,
Canada balsam	1 drachm
Oil of thyme or lavender...	1 ounce

The resins should be dissolved in the alcohol by means of a water bath. The plate should be warmed as hereafter to be described, heat aiding the hard and bright drying of the varnishes.

Amber varnish, which is applied to a cold plate, is made as follows:—

No. 1.—Amber, in fine powder... ...	1 ounce
Chloroform	16 ounces
Or,	
No. 2.—Amber	1 ounce
Benzole...	16 ounces

The amber should be heated in a closed vessel to a temperature of 570° Fah., when it will begin to soften. It can then be dissolved readily by the solvents.

Varnish may crack through swelling after it has been applied to the film. This may be caused by bleached lac having been used. To cure this defect the varnished film should be subjected to the vapour of alcohol. This will dissolve off the varnish, and leave the plate in its original state. It should then be varnished with different varnish. Varnish may also contract; this is probably through the use of copal in its composition. The same remedy should be tried. Should the varnish dry matt, it is probable that sufficient heat has not been applied after coating the film with it. If it dry matt in parts, it is probable that the preliminary heating of the negative has been unequal.

In some cases but a few prints may be required from a

* Bleached lac absorbs moisture, and tends to make the varnish crack.

negative. As a resinous varnished film is difficult to wash off the glass, the following may be substituted for the spirituous varnish :—

Albumen	...	...	...	1 part
Water	...	...	...	3 parts

A dilute solution of gum-arabic may be used instead. In both cases the drying of the film should take place spontaneously. If the collodion film be dry, it should be wetted previous to the application of the albumen or gum solution.

MANIPULATIONS IN WET-PLATE PHOTOGRAPHY.

CLEANING THE PLATE.

The plate should first be breathed upon to ascertain what state of chemical dirt it is in. If the surface feel rough to the touch it should be immersed in nitric acid and water, and allowed to soak for a few hours. It should then be washed under the tap, and allowed to drain. If there be many plates to drain, remember to keep them separate one from another. A good method is to stand them on edge on the floor, supporting one another, as in building the first storey of a card house. It frequently happens, if the water contain chalk, that should the edge of one be allowed to rest against the surface of another plate, a chalky line is formed on the latter, entailing the application of acid once more. When drained, the tripoli powder solution should be applied with a tuft of cotton wool. A small quantity, sufficient to form a pool the size of a sixpence, may be poured on the plate and rubbed well over the surface. It is sometimes recommended to let this dry before being rubbed off with the diaper duster. It is believed, however, by the writer, that it is preferable to rub it off whilst moist, taking care that there is no arrest of motion before the surface appears dry.

A perfectly dry silk handkerchief or chamois leather should be employed to give the final polish. (These should be well washed in soda or pearlash and water, and well rinsed and dried before use.) The motion of polishing the plate should be light, and in a circular direction. It should be remembered that this polishing generates electricity, positive on the plate, and negative on the rubber, and that electricity prevents the adhesion of the film to the glass. This electricity may be dissipated by passing

the handkerchief or cloth *very* slowly over the surface. This allows the re-combination of the two electricities. Sometimes it is useful to have a plate-holder on which to clean plates. There is none better than that described by Mr. J. Paget, which is as follows :—

"The cleaner . . . . consists of a board covered with two thicknesses of flannel, held down by strips of wood on all sides except at C (fig. 1), where there is a thumb-hole. These strips are

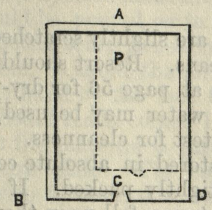


Fig. 1.

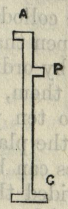


Fig. 2.

of the same thickness as the glass, or are feathered down to that thickness at the inner edge, and enclose a space of the exact size of the glass, which is thus held firmly in its place. The strips are not under-cut. On the contrary side of the board from the flannel is fixed a strip of wood along the side B D, and a peg at P, both of which are shown in fig. 2, which is a section, through A C, of fig. 1. A hole is bored in the table at the distance P C from its edge, so that the cleaner is held perfectly fast by the strip and peg, without any assistance from the hand; and when a plate is placed in it the glass is, for practical purposes, as firm as if it were glued to the table, but yet it may be removed by the thumb in a moment. When part of the table can be spared for the purpose, the flannel may be laid upon it and the strips screwed through the flannel to the table, thus forming a fixed plate-cleaner of the very simplest possible construction."

Where different sizes of plates are used, L pieces, giving the proper dimensions, may be made as shown in the diagram.

Breathing on the plate tells if the polishing be sufficient, but care should be taken that no small particles of saliva fall on it; the breath should leave the plate in a regular and even manner. The best position for allowing the breath to fall on it is from one end or side, keeping the mouth nearly on a level with the upper surface. The moisture from the breath should

be fully dissipated before a plate is attempted to be re-polished. If this rule be neglected, transparent patches on the plate will be visible when breathed on again. It should be borne in mind that each plate has *two surfaces* to be cleaned.

When old varnished plates are to be used again, they should be allowed to soak in soda and water (one ounce of washing soda to two pints of water). This will generally secure the film leaving the plate. The plates should be treated as above. Should the films be unvarnished, hot water may be employed to remove the collodion.

It may happen that plates are slightly scratched, and refuse to become clean by ordinary means. Resort should then be had to albumenizing them, as given at page 56 for dry-plates (one part of albumen to ten parts of water may be used). In this case breathing on the plate is no test for cleanness.

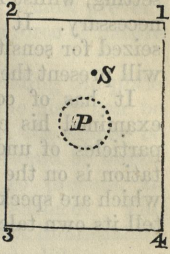
Clean plates can be well stored in absolute contact with one another, provided they are tightly packed. If loosely packed, any small particle of grit that may fall upon them will be liable to cause scratches. Another method of storage is in plate boxes. This is not satisfactory, since all glass in contact with the air is liable to attract moisture. Clean blotting-paper is the best substance to pack clean plates with.

COATING THE PLATES WITH COLLODION.

It is inadvisable to coat a plate with collodion from a bottle which can contain more than five or six ounces, and this sized bottle should not be full, but should only be filled up to an inch or so below the neck. A larger one is unwieldly; and the collodion is apt to run down the sides of any bottle that is full. Convenient pouring bottles have been introduced for the dark room, but for out-door work the ordinary six-ounce bottles will answer well. It is recommended that corks should be used in lieu of glass stoppers: the former clean the inside of the neck of the bottle from the thick collodion; whilst the latter are apt to stick fast, or to be forced out by the ether vapour when the temperature is raised.

If practicable, the collodion from the plate should not be poured back into the bottle from whence it came, as any dust contracted from the air would probably appear on the next coated plate; owing to the evaporation of ether, also, the collodion will become too thick for use before many plates are coated.

Dust from the plate should be removed with a broad badger-hair brush before coating. The brush should be perfectly dry, and care should be taken not to generate electricity by too vigorous a motion.



If a pneumatic plate-holder be used to hold the plate to be coated, it should occupy the centre of the plate as shown in the figure by P. The plate should be held at first horizontally, corners 1 and 2 being away from the manipulator. The collodion should be poured on to a spot S, the mouth of the bottle being as nearly touching the plate as possible, to avoid the formation of air-bubbles. S is fixed by the fact that the wave of collodion should reach corner 1 when such a quantity is on the plate as is just sufficient (or barely more) to cover the entire plate. The collodion wave should then be caused to flow to 2, next to 3, and finally the excess should be poured off at 4. The wave should be directed successively to these points by slightly tilting the plate. When the collodion is poured off at 4, the plate should be rather more tilted, till the excess has been got rid of, when it should be made to resume nearly an horizontal position, a slight inclination in the direction of 4, however, being preserved. A gentle rocking motion should now be given to the plate, but no grinding of the glass from the edges of the plate against the neck of the bottle should be allowed. The small particles of glass would fall into the collodion, and appear as imperfections on subsequent negatives.

The collodion wave should not pass over the same spot twice, especially near corners 1 and 2. If it do, the almost invariable result is a thickening of the film at that place, and an appearance of a "curtain" by transmitted light. Should an air-bubble spoil the surface of the film, a second coating of collodion may be given. This will generally correct the fault.

When the collodion at 4 refuses to drop, and the film at 2 appears in a tacky state to the finger, the plate is ready for immersion in the bath. This "setting," as it is technically termed, is brought about by the partial evaporation of the ether and alcohol from the collodion.

Should no pneumatic plate-holder be at hand, the plate should be held by the thumb and middle of the first finger by corner 2, the extreme point of the corner alone being held by the cushion of the thumb. This manner of holding will enable the entire

plate to be covered, and the disfiguring uncoated triangular portion at the corner 2, so often seen, will be avoided.

In hot weather two minutes will generally suffice to cause setting, whilst in cold weather five or six minutes or more will be necessary. It is important that the right moment should be seized for sensitizing the plate, otherwise defects in the negative will present themselves on development or during sensitizing.

It has of course been supposed that the manipulator has examined his collodion to ascertain if it be free from small particles of undissolved pyroxyline or dust, also that no incrustation is on the neck of the bottle. The former will give plates which are specky in appearance, whilst the latter will speedily tell its own tale.

SENSITIZING THE PLATES.

The glass plate having been coated as stated, the next operation is the sensitizing of the film for the impression of the image. The corner of the plate from which the collodion has been poured off should be allowed to remain downwards. When placed on the dipper in this position the plate should be *gradually* lowered, without stoppage, into the bath.

When once covered, the plate may be moved up and down (and also horizontally if the bath be large enough) till all greasiness, caused by the repulsion of the aqueous for the alcoholic solution, has disappeared. This will probably take two minutes in cold, and only one in warm, weather.

When this motion of the plate in the bath is not attended to, it may happen that the alcohol may collect in rivulets on the surface of the film, preventing the access of the sensitizing solution to the bromo-iodides beneath them. When, finally, the alcohol has become dissolved in the water, the beds of these rivulets would become less sensitized than those portions which have had access at once to the bath solution. The result might be a streaky negative. By washing the alcohol off, as described, no rivulets can collect; the film must become evenly sensitized, even before the total greasiness has disappeared.

When the greasiness can no longer be traced, the plate should be allowed to remain at rest for another minute and a half to three minutes, when, after a few more vertical motions in the bath, it may be taken out.

This last operation is generally performed in a hurried manner.

Were more thought ordinarily exercised over every operation, many vexatious failures and loss of time would be avoided. A very little reflection must point out the utility of abstracting the plate *very* slowly. The capillary attraction of the liquid in the bath for the liquid on the plate will, if time be given, almost prevent the necessity of draining. The advantage of this force of nature is entirely lost by a rapid removal of the plate.

In taking the plate out, then, the dipper holding the plate should be very slowly raised, till a corner of the plate can be seized by the fingers of the disengaged hand. If the dipper be not a silver wire one, the top edge of the plate should be forced away from it, as far as practicable, in order to prevent an accumulation of bath solution between the two surfaces. The plate is then raised till it is clear of the bath, and is immediately turned to the position it should occupy in the dark-slide.

It will be remarked that different lengths of time for sensitizing are given above. To be able to understand the reason of these differences, the nature of the sensitizer, the proportion of iodide to bromide in the collodion, the strength of the bath solution, and the temperature must be considered.

1st. With a strong bath solution a less time is required for fully sensitizing the film than with a weak one.

2nd. The greater the amount of bromide in the collodion the longer the operation will take. It has been proved that it takes nearly four times as long to completely sensitize a bromide as it does to sensitize an iodide; consequently, the greater the amount of bromide in the film, the longer will the sensitizing take to complete.

3rd. The warmer the weather the shorter will be the time of immersion, as cold renders the access of the bath solution to the film difficult.

A general rule for the length of time required for sensitizing ordinary commercial collodion is to immerse the plate three minutes in summer and six in the winter. Practice will enable the operator to judge of the lengths necessary between these two extremes.

The bath solution should be freed, before work is commenced, of any deposit at the bottom of the bottle that is apparent.*

* When filtration is resorted to, the honeycombed side of the filter paper should be next the funnel, and it should be moistened with distilled water before the solution is run through. Some filter papers contain contamination which is injurious to the bath.

Filtration should not be resorted to more than is absolutely necessary. Decantation of the clear liquid from the sediment should first take place, and then the remainder (containing the deposit) may be filtered if required.

MANIPULATIONS AFTER SENSITIZING THE PLATE AND BEFORE DEVELOPMENT.

After the plate has been slowly withdrawn from the bath, it should be carefully drained on a pad of blotting-paper (three or four thicknesses at the least should be used), the end that will be lowest in the slide being pressed on to the pad. By this operation stains from accumulation of bath solution will be avoided.

The dark slide should be opened at the back, and held *nearly vertical*, and the plate put upon the silver wires after the drainings from former plates have been removed. This vertical position is of importance, and one which in practice is often neglected. The silver solution is by it prevented from running back over the plate and causing markings.

The back of the plate should next be carefully wiped with a pledget of blotting-paper or rag, to remove any nitrate of silver solution which may have collected on the back. Should this precaution be neglected, horse-shoe markings (see "Defects in Negatives") on the developed image may be looked for.

Should the exposure be of considerable length, or if the time between placing the plate in the dark slide and development be likely to be long, place a moistened sheet of blotting-paper at the back of the plate. This will prevent "halation," and will keep the film moist through the evaporation of the water it contains.

Finally, place a strip of blotting-paper at the lower edge of the plate, and just in contact with the film; this will prevent the accumulation of the bath solution during exposure. The practice of letting the blotting-paper come between the film and the silver wires which hold the plate is to be condemned, for it should be recollected that the inner surface of the silver wires is made to coincide accurately with the surface of the ground glass; hence, if the film do not touch the silver wires, the whole focus of the picture is altered.

The slide should then be closed, wrapped round with a cloth if

to be carried far, and held in the position it will occupy in the camera during exposure.

The view should of course be previously focussed on the ground glass of the camera. A few hints on the method of focussing may not be amiss.

The point of view having been chosen, and the camera placed approximately in position, the operator will pay attention to securing sharpness of each object to be portrayed. He will guess which diaphragm or stop to use, and having inserted it in the lens, will proceed to bring every point as nearly as possible into good definition on the ground glass.

Should an architectural subject be the subject of the picture, it will be necessary that the perpendicular lines should be strictly parallel. As a rule, if it be a near view, the camera will have to be tilted in order to bring in the whole of the subject; but before resorting to tilting, the front board of the camera which carries the lens should be raised to its full extent (*i. e.*, as far as the slot which secures the screw will allow). This will raise the image from the bottom of the ground glass, and now the necessary amount of tilting may be given. When tilted sufficiently, the surface of the ground glass must be brought perpendicular to a horizontal plane—that is, it should be plumb. If the glass occupy any angle to the vertical, vertical lines which should be parallel in the picture will converge. It may here be remarked that the ordinary single lens will always give curved straight lines towards the margin of a picture; hence architectural subjects should always be taken with a doublet, or any non-distorting lens. A spot about one-third way from the centre of the picture and the edge should be selected, and that brought into sharp focus. If the diaphragm used be small enough, this will generally secure an equable focus throughout the picture; other points should then be selected and tried for focus; and that point which makes the focus generally sharpest should be selected as final. It should be noted that *the* object of interest should be especially sharp; a slight lack of definition in other portions being sometimes an improvement, as less distracting to the eye.

Should it be a landscape that is to be photographed, the swing-back need not be kept in a vertical position, as the perspective will not obviously suffer. In fact, it often happens that a large diaphragm may be employed, by judiciously using the

swing-back to bring the foreground and distance into focus together, for the nearer the object the longer will be the focus, and *vice-versa*. Hence by pulling out the top of the swing-back the lengthening of the focus is obtained, instead of by the employment of a small diaphragm.

Care should be taken that the screws fixing the camera to the legs are tight, and that the latter have a firm grip on the ground. In soft situations this is especially to be watched.

After the object to be photographed has been properly focussed, the slide should be placed in the camera without jerking. The front board of the slide should then be raised, and the exposure commenced. (It is often advisable to place the focussing-cloth round the camera and over the dark slide, to prevent any possible access of light to the plate, except through the lens.) The grand rule for timing the exposure may be stated to be—"*Expose fully for the details in the deepest shadows; the high lights will take care of themselves.*" During the time of exposure never touch the camera or legs with the hand; it should be remembered that the human body vibrates to a certain extent, and that these vibrations might be communicated to the camera.

It frequently happens that a negative has to be taken in windy weather. Lulls in the force of the wind should be watched for, and the cap replaced on the lens during the gusts. A heavy stone suspended by a string from the top of the camera-stand will often check oscillation during exposure.

The same precautions in carrying the dark slide to the developing room or dark tent should be observed as those already given in carrying it to the camera.

DEVELOPMENT.

Having filtered the developer, if requisite, and placed the necessary quantity in the *clean* developing cup, the plate should be taken out of the slide. Care must be taken that in no case is the plate laid horizontally, or in any other direction different to that in which it has been carried from the camera, though the angle of inclination may be much modified. The *developer is then with an even motion swept* without stoppage (the rim of the cup almost touching the film) over the plate till the latter is

completely covered. As little of the solution as possible should be allowed to flow over the edges.*

The writer prefers to keep the long edge of the plate next to him, whilst the corner of the plate where any drainings may have accumulated is away from him. The plate is held with a *small* inclination downwards away from the body, and then the developer is applied as above.

The developer is then worked round and round to each corner of the plate in succession till the image is fully out. If properly exposed, the image will take some half minute to appear fully, and the deepest shadows alone should remain of the green tint of the unaltered iodide and bromide of silver. An under-exposed picture will take a long time to bring out; whilst an over-exposed picture will flash out at once, and, unless the developer be immediately washed off, fade away and give a flat and fogged negative. A properly exposed and developed picture should, by reflected light ("looking down on the plate"), appear as a well-defined and graduated image lying on a ground of iodide of silver; whilst, by transmitted light ("looking through the plate"), every detail should be visible both in shadow and high light. With proper exposure the developer may stay on a negative for a long time without injury.

A plate-holder† is recommended for holding the plate during development. If not at hand, the corner must be held as described in the article on Coating the Plate (page 29), or else the plate may be supported in the centre by the tips of the fingers. In developing large plates without the aid of a plate-holder, a cork, cut to a point, and fixed in a bottle, may be used as a support. The cork supports one corner and the manipulator's fingers the one opposite.

The following maxims are worthy of attention:—

1st.—Always have a weak and a strong developer in the field and in the dark-room.

2nd.—Think well as to which will answer your purpose the better, remembering that with a strong developer contrasts of

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* If the developer flow over the edge of the plate it carries much of the free silver with it, which is necessary to give density to the image. Some writers advocate the loss of this free silver. I cannot advocate it from theory or experience, excepting where too much vigour in the resulting picture is feared.

† Not that one which has been employed for holding the plate during coating with collodion.

light and shade are subdued, whilst with a weak one they are increased.

3rd.—Use your developer before it attains the reddish brown colour, and do not use methylated in place of pure spirits of wine.

4th.—The less acetic acid used the more harmonious will be resulting picture.

5th.—Reject a negative which is either under-exposed or much over-exposed.

INTENSIFICATION.

Practice alone can give the operator a knowledge of the exact amount of density required in a negative. Pictures are often spoilt by bringing up the half-tones to a nearly equal density with the highest lights. It should be recollected that the printing power of a negative not only depends upon the *quantity* of deposited silver, but also upon its *colour*. If a negative, on account of its density and colour of *deposit*, allow the *deepest shadows* to print to a depth verging on bronzing, and at the same time leave the *highest lights* white, or very nearly so, any further intensification will be detrimental.

The operator's judgment must decide whether he should use those intensifiers which cause increased deposit, or those which merely cause change of colour.

Should the former be decided upon, and if the picture have been slightly over-exposed, it is well to stop all further danger of development by treating it with a weak solution of iodide and bromide of potassium for a minute or two. This will completely check all further action excepting that of intensification. A more common method of treatment is to fix the picture first and intensify afterwards.

Intensification before fixing should be conducted as laid down for development. The intensifier should be flowed over the plate first, next the silver added in the cup, and then the intensifier from off the plate poured back. By this means a perfect mixture of the two is obtained. The intensification should then proceed till the requisite density is arrived at, or till the solution becomes turbid in the case of iron, or deep brown in the case of pyrogallic acid. In the latter cases fresh solutions, with added silver, should be used till the intensification is completed.

In landscapes and in portraits the highest points of light alone should appear opaque before fixing.

If intensification be proceeded with after fixing, it is advisable to use the iodine solution first (No. 4, page 22).* This tends to prevent a red deposit forming on the shadows when the iron or pyrogallic acid formulæ are used. This operation may proceed in diffused light. It is more difficult to decide on the printing qualities of a negative which is intensified by change of colour. Practice alone can enable the operator to be sure that he has obtained the necessary opacity to the actinic ray.

FIXING THE NEGATIVE.

Few remarks on this operation are necessary. If hyposulphite of soda be used, the plate may be immersed in it in a dipping bath or flat dish; if cyanide of potassium be used, care should be taken to wash the plate directly all the unaltered iodide and bromide of silver is dissolved. This may be known by reversing the plate, and noting if the green colour has totally disappeared.

After *development*, *intensification*, and *fixing*, the plate should be *well washed*. If, in fixing, hyposulphite of soda be used, the washing must be of *considerable* duration.

DRYING AND VARNISHING THE NEGATIVE.

The plate may be allowed to dry either spontaneously or by the application of heat; but in no case should both processes be employed. Quick drying, as before stated, gives an increased density to the image; thus, if a negative be dried partially by one and partially by the other, the gradations will be false.

Before applying the varnish (see page 24), the plate should be warmed.† The varnish should then be flowed over like collodion, the same gentle rocking motion being preserved as in coating a plate. When the excess has run off, any varnish collected at the lower edges may be removed by pressing them down on a pad of blotting-paper. The plate should now be thoroughly heated. When cool it is ready for the printing operations.

A neat appearance is given a negative by scraping off the film‡

* If the negative have dried before it be intensified, the edges should be varnished with Bates's Black Varnish, to prevent the film leaving the plate.

† The soft part of the back of the hand, between the thumb and first finger, should just *not* be able to bear the heat of the plate.

‡ When dry, and before varnishing.

round each edge of the plate to a distance of about one-eighth of an inch. This also prevents damp penetrating between the film and the glass plate, as the varnish coats both the margin and the film.

The best source of heat is a Bunsen burner or paraffin lamp, the plate being moved briskly over the top of the chimney; the next is an ordinary fire; and the worst, the flame of a spirit lamp. In using this last, after applying the varnish, great care is requisite to prevent the flame setting fire to the spirit.

It sometimes happens that the film tends to peel off and split whilst drying. The application of stale beer to the negative will prevent this fault. A weak solution of gum has been recommended, but gum has the property of absorbing moisture; it swells, and causes the film to crack, the varnish being unyielding. Gum should, therefore, not be used unless the negative is required to last but a short time. A solution of albumen will answer equally as well as the beer.

DEFECTS IN NEGATIVES, ETC.: THEIR CAUSES AND REMEDIES.

Hitherto there has been little or no mention made of defects in negatives, and it is proposed here to point out, under different sub-heads, their causes and cures.

DEFECTS CAUSED BY THE GLASS PLATES.

If the negative appear to be fogged in certain places while the remaining portions are bright, a dirty (*i e.*, not chemically clean) plate may be suspected. If a scum be apparent at the reverse side of the plate the suspicion is confirmed. The dirt may arise from improper cleaning of the plate with the tripoli powder or whitening (see page 9), or else from compounds unattacked by these solutions, such as the remains of corrosive sublimate (bichloride of mercury) used in the intensification of a previous negative on the same plate.

The remedy in the first case is apparent; in the last case the plate should be washed well with water, and then steeped in nitric acid and hot water (one ounce to the quart is sufficient), and allowed to soak twenty-four hours. This will probably cure the evil, after the plate has been thoroughly rinsed with cold water, and cleaned in the ordinary manner. Sulphuric acid and

bichromate of potash or a solution of cyanide have been recommended instead of the nitric acid; they seem to have no advantage over it, however. Should this fail, the plate may be coated with a solution of albumen as described in the "Gum-Gallic Process."

Circular and straight transparent markings are sometimes met with when a negative has been taken on a plate that has been put away as clean. Their occurrence leads to the suspicion that the plate has since become damp, or that a damp silk handkerchief has been used in polishing, or, perhaps, that one has been used which has been improperly washed with soap, and has not been thoroughly rinsed out.

Sometimes the collodion sets in streaks from one corner or edge, forming large ridges and furrows on the plate, which become only too apparent on sensitizing.

This is frequently caused by a roughness at an edge of the plate, chippings usually being detected on examination. Filing the edges with a rough file, or even filing too much with a fine one, will cause this defect. The collodion clings to inequalities, and by molecular attraction small pools are formed, which finally run over on the plate, and cause the ridges. The remedy for this defect is to re-grind the edges of the plate carefully, or, if only one edge be rough, to pour off the collodion towards that edge.

Opaque streaks in a negative will sometimes occur. Scratches in the surface of the plate usually account for them. There is no cure for this defect—the plate must be rejected. If round transparent markings of the size of a pin's head are apparent in the negative, when new glasses are used, a crystalline deposit on the surface of the plate must be looked for.

DEFECTS CAUSED BY THE COLLODION.

When the plate is taken out of the bath, should the film appear much less opaque at the end at which the collodion was poured on than at the lower end,*—1st, the collodion has been allowed to set too long; 2nd, it has been prepared with too highly-rectified solvents, and ether in excess; or, 3rd, there is alcohol in excess, causing the plate to dry at the top before it has set at the bottom.

* The portion of the image developed on these semi-transparent parts would be very feeble.

The remedies are, in the first case, apparent; in the second, leaving the bottle of collodion unstoppered till the necessary amount of ether has evaporated, making up the quantity with alcohol, and then adding one or two drops of water to the ounce; in the third case, the addition of a drachm of ether and a quarter of a grain of iodide of cadmium to the ounce of collodion.

The next defect that may be noticed is the collodion showing opaque markings, after sensitizing, at the corner whence it was poured off. This may be caused by too much iodide and bromide in the collodion, in which case, plain collodion should be added; or, it may be caused by the collodion being too alcoholic. If the film be allowed to set longer before immersion in the bath, it is probable the fault will be corrected.

It sometimes happens that the defect noticed in the last paragraph is exaggerated, the iodide from the film (and the film itself in places) leaving the plate entirely. This is caused by not allowing the collodion to set sufficiently; the water in the bath acts on the pyroxyline before it becomes gelatinous (from the evaporation of the ether and part of the alcohol), and the cotton is precipitated. The last remedy given above must be resorted to.

Curtains on the film have been noticed in "Coating the Plate" (page 29), and the reason given of their existence. The cure was also suggested.

It sometimes happens that there are markings in the film, giving it the appearance of a fine network or crape. This arises from the use of too gelatinous a sample of collodion, or from a strong cadmium bromo-iodizer.* The remedy, in the former case (in which the plain collodion alone gives this structure), is to add a more limpid sample to it. If caused alone by the latter, keeping will probably rectify the evil; whilst if the result be from both causes, the addition of a limpid alkaline-iodized collodion is recommended.

Should the developed image appear weak, and the film be opalescent, it is probable, if the collodion be in fault, that it is deficient in pyroxyline, either from sufficient not having been at first added, or from the property that old collodion acquires of dissolving an extra quantity.

A lack of half tones in the image is caused by using a collodion whose pyroxyline has been made at too high a temperature, or

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* Solvents too diluted with water may also cause this defect.

by the iodine in it being liberated to excess.* The defect suggests the cure.

Should the film split on drying, it is probable that the collodion used contained too much ether. Pyroxyline made with too strong acids will also cause the evil. Mixing with another sample of collodion will probably be the best cure.

If the pyroxyline be made in weak acids, the film will generally adhere to the plate; but if a gelatinous kind be used, falling away will frequently occur.

A scum floating on the bath may denote the use of a too highly bromo-iodized collodion; if this be the case, the latter should be mixed with a small quantity of plain collodion. Acetate of silver in the bath is likewise a cause of scum. It should in all cases be filtered out, or be removed by drawing a strip of clean blotting-paper along the surface of the bath solution.

An under-iodized collodion will cause the developed image to appear flat and lacking in density (if it arise from the collodion). Try adding an extra grain of iodide of cadmium to the ounce. If the collodion be too highly *bromized*, the same result will occur.

DEFECTS CAUSED BY THE SENSITIZING BATH.

A line across a plate, seen after sensitizing, denotes a stoppage in the motion of immersion.

Lines in the direction of the dip are generally caused by the bath being too alcoholic. (Each time a plate is immersed the water absorbs a percentage of ether and alcohol.) The excess may be removed by raising the temperature of the solution to about 200°. The alcohol is driven off in vapour at that temperature, whilst the aqueous solution remains behind. The solution may also be boiled down to half its original bulk, and be made up to the proper strength by the addition of purified water. These lines may also occur through the use of collodion with a very repellent film. This may be remedied by shaking it up with carbonate of soda, and decanting from the residue, or by the adding to it one or two drops of water.

A scum on the film may be caused by the use of a bath containing too much nitrate of silver. Test its strength, and add water, if requisite, filtering out the iodide that may be precipitated.

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* Shown by the deep colour it assumes.

A bath carefully used will rarely get out of order. Sometimes, however, by accident, it may become contaminated by foreign matter, and the negatives be poor, flat, and, in some cases, useless, through fog on the shadows. To render the bath fit for work, resort should be had to the action of sunlight (after neutralizing the acid with carbonate of soda or freshly precipitated oxide of silver), as explained in the purifying of water (see last chapter). This is the best and, probably, the only legitimate cure for a bath that gives negatives of the foregoing description, except evaporating the solution to dryness and fusing the nitrate of silver. This latter is, however, not highly recommended, on account of the reduction of some portions of the nitrate of silver to the condition of nitrate. The addition of permanganate of potash* has also been recommended. It is at the best a doubtful cure.

Should these means fail, the best plan to adopt is to precipitate the silver, and make a new bath from it, as given in the last chapter.

There may be another cause of flatness in a negative, viz., the bath being below its proper strength of nitrate of silver. A very delicate method of testing for its strength is as follows:—Measure with a pipette (or dropping-bottle) one hundred drops of the solution to be tested; rinse the pipette, and drop from it, into the silver solution, a solution of salt and water (thirty-five grains to the ounce), till no more precipitate of chloride of silver is seen to form. The number of drops added to the silver solution will be the number of grains of nitrate of silver in the ounce of bath. It will be found advantageous to heat the solution to be tested, as the last formation of chloride of silver will be more distinctly visible.

Transparent pinholes on a negative, after fixing, are caused either by dust, or through the bath being over- or under-iodized. Should they be caused by the bath being *over*-iodized, a granular appearance will, by reflected light, be visible on the surface of the plate. The granules are iodide of silver separated from the bath. The remedy for this is to take one-fourth of the bath solution and dilute it with three times its bulk of water. This will cause an emulsion of iodide, which can be filtered out. Solution may then be made of proper strength, either by boiling

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* Permanganate of potash, fifteen grains; water, one ounce. The solution to be added to the bath till a faint permanent pink colour is given.

down, or by the addition of fresh crystals of nitrate of silver. Another method recently proposed is to add a few drops of hydrochloric (muriatic) acid to the solution with constant agitation. This carries down the excess of iodide along with the chloride.

The remedy for an under-iodized bath solution needs no comment. Stains on its lower end may arise from the plate not being properly drained; or, if properly drained, from the plate being reversed from its proper position whilst in the dark slide.

Fog may be caused by the bath. A separate article will be given on this defect, its causes and cure.

When the bath is too acid, hard negatives, wanting in detail, often result. The acidity may arise from the use of collodion which has liberated iodine, and acidified the bath solution.* This may be remedied by adding an alkaline solution to the bath. They may also result from the developer, through causes which will be stated.

Transparent flashes and curtains are generally caused by the free nitrate of silver drying on portions of the plate, owing to the length of time elapsing between taking the plate out of the bath and developing it.

Negatives are particularly liable to this defect if the bath be at all old and alcoholic. Careful draining, using damp blotting-paper at the back of the plate in the slide, and other obvious precautions, should be used.

Opaque markings, like lines, may occur through the bath solution collecting and running down the plate, particularly if the plate be not fully sensitized. The rivulets of bath solution complete the sensitizing of the plates in those portions alone, hence the image is stronger at those parts. The cure is plain.

Horseshoe-markings, of about the size of a small pearl button, may occasionally be met with. They are generally to be discovered when a collodion is used which appears opalescent after sensitizing. They arise from the reflections from the small drops of bath solution that accumulate on the *back* of the plate. It is needless to enter into the exact cause of the horseshoe form; but it can be rigorously demonstrated as resulting from the shape and motion of the drops. By carefully wiping the back of the plate before placing it in the slide this trouble will cease.

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* The iodine liberated combines with the nitrate of silver to form iodide of silver, and liberates nitric acid.

DEFECTS CAUSED BY DEVELOPMENT.

Lines may occur on the negative by the stoppage of the developer when poured over the exposed plate. The stoppage is generally the result of carelessness, or of the drying of the film after removal from the bath. In the latter case, more of the developer must be taken to enable the plate to be properly flooded. The free nitrate of silver having partially dried on the film, but little will be carried away by the developer over the edge of the plate. The defect may also arise from the repulsion of the free nitrate of silver on the film from the developer, either through excess, or the contrary, of alcohol.

Lines may also be caused by leaving a small quantity of water in the developing cup. This will not readily mix with the alcoholic developer, and will cause development to be delayed on portions of the negative.

That the image is poor and flat may arise from washing off the free nitrate of silver from the plate by the developer; from the use of too strong a developer; or from the bath or collodion, as explained in the two previous articles.

In addition to negatives becoming hard from the collodion or bath, they may have the same defect from the use of a weak developer, from one with too much acid in it, or from under-exposure. The first two causes may arise from the protosulphate of iron changing to persulphate, as explained in page 20. The remedies are at once apparent.

When the developer refuses to flow evenly over the film, and seems to be repelled by it, either too much, or too little, alcohol has been added. The remedy for this is also apparent.

A scum on the developer, formed during development, may denote a want of acetic acid.

DEFECTS CAUSED BY INTENSIFYING AND FIXING.

The chief defects that arise through intensifying are those which may also occur in development. Fog and a red deposit are chiefly to be anticipated. The former may occur before fixing if the pictures be over-exposed; the latter, both before and after fixing, by the addition of too much free nitrate of silver to the intensifier; or again, after fixing, by the imperfect washing of the film before the intensifier is applied. The red stain will

often yield to treatment with a solution of acetic acid and water (half to half). Fog may be reduced as given at page 47.

It should be noted that the larger the amount of silver added, the more rapid will be the intensification; but the half-tones will not be brought up proportionately to the high lights. The smaller the quantity of silver used, the greater will be the comparative force given to them, and the longer time it will take.

Thus, a negative lacking in contrast may be corrected by using an intensifier with large, and one too rich in contrast with small, doses of silver.

The defects caused by fixing are few in number: the chief is that caused by the cyanide of potassium eating away the half-tones, or the washing off being too long delayed. If strong cyanide be used, and it be allowed to stop in its flow over the plate, a weak line may become apparent. A film splitting after varnishing may often be traced to the use of hyposulphite of soda as a fixing agent, and a subsequent imperfect washing.

DEFECTS CAUSED BY VARNISHING.

Several defects may arise in varnishing. First, and most serious, the film may dissolve away. This is caused by the solvent used in the varnish being stronger (*i.e.*, of less specific gravity) than that employed in the collodion. The addition of a small quantity of water may effect a cure, or varnishing the plate cold, and *then* heating it, may answer in some cases.

Should a transparent mark show across a negative immediately after varnishing, it is probable that the solvents are *slightly* too strong, and that the varnish has not been allowed to flow over the film without stopping. The cure suggests itself.

A matt surface denotes (as shown on page 25) that sufficient heat has not been applied before or after the varnishing.

Ridges in the varnish on the film *may* denote that too much of the solvent has been allowed to evaporate by repeated applications to other plates. Add more spirits of wine (7·840 methylated will answer). Ridges may also arise through rough edges of the glass, or from dust on the film.

Other small defects may sometimes be noticed. A little thought will generally trace their cause, and suggest the remedies.

DEFECTS CAUSED BY THE DARK SLIDE.

Should it happen that at one or more corners the silver is reduced on development, so as to cause opaque marks, the slide should be examined. The evil may arise through the wires which support the plate not being made of *pure* silver. A coating of varnish applied to the wires will prevent the mischief for the future.

Opaque streaks seen after development, running from one corner, may possibly denote the ingress of light into the slide.

Transparent marks of the size and shape of a pin's head, with a very small opaque dot in their centres, may show that dust has fallen from the front of the dark slide on to the film. The inside of the slide should be carefully wiped out with a damp cloth. Similar spots may arise from the use of collodion made with pyroxyline prepared with dilute acids (see page 11), though in this case the central dots would not be visible.

FOG ON WET-PLATE NEGATIVES.

Fog being one of the commonest defects in a negative, it will be useful to point out in one place all the causes that may bring it about.

Over-exposure in the camera is one of the common causes, particularly when working with newly-iodized collodion.

The contamination of the nitrate of silver bath by organic or foreign matter is another frequent cause of fogging. It is easy to account for the organic matter in the bath, the dust and other impurities that float in the atmosphere of the dark-room being one source. Distilled water, as commonly sold by chemists, may also contain it, as their stills are frequently used for the distillation of essential oils, and the remains of these are carried into the water. A bath made of impure gutta-percha may also account for its presence, as will the wooden case of a glass bath, provided the bath solution happen to touch the wood whilst being poured in or out. In all these cases sunning the bath solution, or evaporating it down to dryness, are the most effectual remedies. Permanganate of potash may be employed as a corrective, but, as before stated, is not recommended.

Alkalinity of the bath will be certain to cause fog; as will also acidity, if plain iodized collodion be used. The cure in both

cases has been given, under the head of the "Sensitizing Bath" (page 17).

Diffused light in the dark-room, in the camera, or through the lens, will cause a foggy picture.

Vapour of ammonia, the product of the combustion of coal-gas, sulphuretted hydrogen, are also inducive of fog. All these vapours may be detected by their smell.

The omission of the acetic acid in the developer (or the presence of too small a proportion) will cause the evil, as also a very high temperature in the dark-room.

Many filter papers contain iron, and other impurities, which may induce fog.

METHOD OF DETECTING THE CAUSE OF FOG.

Should a negative appear fogged, first try reducing the exposure; if this fail, try the bath for acidity or alkalinity, as shown at page 17. If the bath be of the right acidity, coat a plate, and having sensitized it, keep it for two or three minutes in the dark-room. Proceed to develop as if it had been properly exposed. Fog will arise, supposing no hurtful vapours be present, either from organic matter, or from diffused light in the dark-room. Try another plate, exposing it in an absolutely dark room. If no fog be apparent, the bath is at fault. With a new bath, it may be that there are vapours present which cause fog. Should fog, however, still be not apparent, coat another, and sensitize as usual, place it in the camera, and draw up the slide, without removing the cap. Develop as for an exposed picture.

If fog be present, diffused light is admitted into the camera; if absent, it is probable that the fogged negative was due to the bad lighting of the subject, or to diffused light through the lens, as in the case in which the sun is allowed to shine directly on the glasses.

To render a slightly-fogged negative fit for printing, apply a solution of iodine and iodide of potassium (page 22, No. 4), and then proceed to dissolve away the iodide of silver formed with cyanide of potassium. With one or more applications of the iodic solution the veil may often be removed without injuring the density of the negative. Another method of reduction is by using the following in lieu of the iodic solution:—

Saturated solution of perchloride of iron ...	1 drachm
Water	1 ounce

This is floated over the negative, and, after washing, the cyanide is applied. By this method the deposit on the shadows seems to be more attacked than that on the lights; it is consequently to be preferred.

Perchloride of Iron in Solution.		Silver in the Film.		Chloride of Silver in the Film.		Protochloride of Iron in Solution.
$Fe_2 Cl_3$	+	Ag	=	Ag Cl	+	2Fe Cl
$[Fe_2 Cl_6$	+	2Ag	=	2Ag Cl	+	$2Fe Cl_2]$

The chloride of silver is dissolved away by the fixing agent; very dilute nitric acid may also be applied at once to the film, but this requires very delicate handling. The acid should be diluted with ten times its bulk of water.

PAPER NEGATIVES.

BUCKLE'S PROCESS.

In hot climates, such as India, the calotype process (or waxed paper process) has been much used, and by some with great success. Large pictures may be produced by it which can *very nearly* bear comparison with those produced with wet plate negatives. Calotype is convenient, owing to the small weight that it is necessary to carry. The following process is the best of a variety:—

A	Nitrate of silver	... 35 grains
	Distilled or purified water ...	... ½ ounce
B	Iodide of potassium	... 35 grains
	Distilled water	... ½ ounce

Mix these two solutions,* and a precipitate will be formed, and if the above proportions of water be maintained the precipitate will retain a more solid and condensed nature, separating itself more readily from the supernatant fluid than would be the case if deficient quantities were used. The deposit of iodide of silver should be washed in small quantities of water (one ounce to each washing being sufficient), as large quantities divide the deposit too finely. The method of washing is as follows. The supernatant fluid should be carefully decanted from the iodide

* The iodide of potassium solution should invariably be poured on the nitrate of silver solution.

the fresh water should next be added, and the deposit briskly stirred in it with a glass rod. When well settled the water should be decanted off as before. The operation of washing should be repeated three or four times.

The iodide must now be redissolved by a solution of iodide of potassium in two ounces of water. The best way of effecting this is to place the precipitated iodide of silver in a two-ounce measure with the two ounces of water and six drachms of iodide of potassium. This will not effect the solution of the iodide of silver, but extra crystals of the potassium salt should be added till it is complete—that is, till the liquid is just *not* clear (*i.e.*, in a semi-transparent state). Should this solution of iodide of silver be too powerful and too thick when coating the paper (which can be known by its deep sulphur colour instead of pale primrose on the paper), two-and-a-half ounces of water may be used instead of the two ounces.

The paper to be used should be as tough and grainless as possible. Turner's paper was the best suited for the process, but at present it is not procurable. Good English paper of the consistency of medium Saxe answers as a substitute.

Cut the sheet of paper into convenient sizes, and pin it by its corners on to a flat smooth board. Apply the solution with a flat cotton-wool brush (or a brush as described for coating plates with a preliminary coating of albumen in the dry plate processes) evenly and plentifully. Let it dry partially. Next wash the sheet in rain water, taking care to expel all air-bubbles, and, having agitated it, leave it in the water whilst a second sheet is coated. When this second sheet is ready for immersion, withdraw the first sheet from the pan and place it in a second dish (likewise containing rain water), and place the second sheet in the first pan, and so on. When well washed in the second pan the paper ought to assume a bright uniform yellow colour, tending to green. The washing will take from one to two hours. Pour off the rain water and rinse two or three times, drain, and hang them up by one corner to dry.

The paper in this state is nearly insensitive to light, and can be kept between leaves of a book or of blotting-paper.

In a dark room pin the paper to a board, as before described, having previously prepared—

1	Nitrate of silver	... 50 grains
	Distilled water	... 1 ounce
	Glacial acetic acid... ...	... 80 minims

2 *Saturated solution of gallic acid in distilled water.

Take six drops of No. 1, to it add six drachms of distilled water, next add six drops of No. 2, and finally add from one to three drachms† of distilled water again. The mixture should then be well stirred with a glass rod. Apply this solution lightly, but plentifully, with the cotton (or other brush) to the iodized paper, blot off the sheets in succession, and place two back to back with blotting-paper between them.

In very hot climates twelve drops of No. 1 and seven of No. 2 may be substituted with advantage for the proportions given above.

A plate of glass of the size of the inside of the camera slide, and having the thickness of the supporting silver wires, having been selected, the corners should be broken off. The glass should then be placed in the frame; the back surface of it will now be on a level with the inside of the silver wires. On this plate place the sensitized paper, and back it with another glass plate. The paper will, when in the camera, coincide with the front of the ground glass.

For a 15-inch focal distance single landscape lens, full aperture, three minutes in bright light will suffice. This may give some sort of a guide for exposure with other lenses.

Take the paper out of the dark slide and pin it on the board as before. Apply equal parts of Nos. 1 and 2, with equal quantities of water, with the brush, and allow the developing action to proceed until it begins to flag. Next apply the solution of gallic acid *very* lightly until the deep shadows begin to dim by transmitted light. The development must then stop, otherwise fog will ensue. This, however, may be arrested by placing the paper face downwards in three or four changes of water, allowing a quarter to half an hour between each change. If, on opening the dark frame, the image on the paper appear perfectly defined, and of a dimly red tint, it is a sign that the exposure has been too long. In this case use one part of No. 1 to two parts of No. 2. Should under-exposure be suspected, two parts of No. 1 to one part of No. 2 should be the proportions used. On foliage or dark

* A stock bottle of gallic acid may be kept, filling up with water, and shaking well after any of the solution is taken out. If all air be excluded from the bottle, it will not turn brown or discolour.

† Heat quickly decomposes a strong solution of No. 1 and 2, consequently the greater the heat the larger should be the quantity of water added. This method of mixing also prevents their instantaneous decomposition.

shadows which do not develop readily, the same proportions of Nos. 1 and 2 should be applied. The brush should then be dipped in the solution containing the ordinary proportions, and be passed over these, together with the other parts, to equalize the development, and to prevent marks arising from the use of the different proportions.

The negative is fixed by immersing the developed picture in

Hyposulphite of soda	2 ounces
Water	32 ,,

The fixing is complete when all the yellow of the iodide has disappeared. This will usually take about half an hour. The paper negative must be washed for two or three hours in running, or frequent changes of, water, and dried spontaneously.

The negative, when dried, is ready for waxing. A flat iron should be warmed, and a small cake of pure white wax be brought in contact on the back of the negative, with its point. The heat melts the wax, and, by moving the iron, the melted wax can be spread over any desired portion of the picture. Blotting-paper should be then placed over the negative, and the hot iron passed over the surface of the blotting-paper till all superfluous wax be removed. The negative is now fit for printing purposes.

It is usual to wax the whole of the negative, with the exception of the sky. Unless the sky be very dense, any portion of it that has been waxed will have to be rendered opaque with indian-ink or some equivalent.

Sensitized calotype paper will only keep two or three days. The quicker it be employed after sensitizing the better will be the result. The paper which has been coated with iodide, but not sensitized, will keep for an indefinite period if protected from light.

GREENLAW'S PROCESS.*

First examine and select thin negative paper, and reject all that show any irregularities, holes, patches of unequal density, &c.; that recommended for Buckle's process will answer.

Make a solution of—

Iodide of potassium	1,000 grains
Bromide of potassium	300 ,,

(For much foliage the latter may be increased to 450 grains.)

Distilled water	40 ounces

* Taken from the YEAR-BOOK OF PHOTOGRAPHY for 1870.

and add enough of pure iodine to give the solution a dark claret colour. Then filter.

Into this place as many sheets of paper as you can with ease, being careful that no air-bubbles exist. Allow the paper so immersed to rest for one hour; then turn the whole upside down, and hang the sheets up to dry, taking off the last drops with white blotting-paper. This may be done in diffused light. When dry, place sheet over sheet evenly in a portfolio in which no other papers, except blotting-paper, are placed. They will then be iodized a dark purple, which will keep any time. They, however, turn a light brown colour. Be sure, in working, that nothing touches the paper, for the very slightest touch will cause a stain in the development.

Nitrate of silver	...	...	...	$2\frac{1}{2}$ ounces
Glacial acetic acid	...	...	...	$2\frac{1}{2}$,,
Distilled water	...	...	...	40 ,,

Now float a sheet of your iodized paper on this (smooth side downwards) until the purple shall have turned an uniform yellow, which is iodide of silver. Allow it to rest for one minute; after this, remove and immerse in distilled water, where it should remain for two or three minutes; if to be kept for some time, remove to another dish of distilled water. Place now on clean white blotting-paper, face upward, and remove by blotting-paper *all* moisture from the surface (these sheets can be again used for ironing out the wax by-and-bye); then place between blotting-paper, or hang up to dry; when *quite* dry, place in your dark slides.

Gallic acid	...	...	...	200 grains
Spirit of camphor	...	...	...	1 drachm
Distilled water	...	...	...	40 ounces

This is a saturated solution of gallic acid; unless preserved from the air it decomposes; the spirit of camphor is added to preserve it. When about to develop, filter, and add to every five ounces one drachm of the following solution:—

Nitrate of silver	...	...	...	30 grains
Glacial acetic acid	...	...	...	$\frac{3}{4}$ drachm
Distilled water	...	...	...	1 ounce

Pour into your dish quickly, and *immediately* float the picture side of your paper, which is slightly visible, on it; being very

careful that there be sufficient liquid to prevent the paper touching the bottom of the dish. Constantly watch until the picture become visible on the back, and the paper have a kind of brown, greasy appearance. Continue the development until, in holding up a corner when the sky is before the light, you cannot see your finger when moved about between the light and the paper. If it be not dark enough before the gallate of silver decomposes, you have under-exposed. Decomposed gallate of silver ceases to develop.

Do not, when examining your paper, lift more than the corner, as an oxide of gallate of silver forms *rapidly* on the surface like a crust, and, on replacing your picture, it causes innumerable marble appearances; as also if you do not place your paper speedily on the solution in the first instance. It may be removed by drawing a sheet of blotting-paper over the surface of the solution. Remove to a dish of common water, and wash out the brown tinge caused by more or less decomposed gallate of silver.

When *well* washed, you may fix it by placing it in solution of hyposulphite of soda, one and a-half ounce to one pint of water, till every vestige of the yellow iodide of silver be removed, after which wash in eight or ten different changes of water; you have then a fine, clear, and dense negative.

THEORY OF DRY PLATE PHOTOGRAPHY.

At page 3, the general action of the preservative on the film has been pointed out with regard to its absorption of the iodine liberated during the formation of an image. It is, however, necessary to enter a little more minutely into its action when comparing it with the free nitrate of silver which takes its place in wet plate photography.

It will be seen, on referring to page 3, that part of the free nitrate of silver becomes, during exposure, partially converted into fresh iodide of silver, by the absorption of the iodine from iodide in the film; that the remaining free nitrate of silver is next reduced to metallic silver by the developer; and that by using a retarder this metallic silver is deposited on the sub-iodide forming the latent image.

Now, when a preservative is used as the absorbent of the

iodine liberated during exposure, it is evident that if some chemical can be found which can reduce the sub-iodide to the metallic state, leaving the iodide unaltered, we shall have a new kind of development, the image being formed *in* the film, and not externally to it. Hitherto no such developer has been found which will reduce the sub-iodide, but, fortunately for dry plate workers, the sub-bromide produced during exposure has been found capable of reduction, the bromide remaining unaltered. For this reason, every dry process which relies on this method of development is prepared with bromide alone, or else bromide in combination with iodide or chloride, or both.

This method of developing the latent image is known as "alkaline development," and is so called from the fact that the addition of an alkali to the developer is necessary.

Ammonia is the alkali generally added to a solution of pyrogallic acid. Ammonia, *per se*, is a developer, and its action may be shown thus :—

Sub-bromide of Silver. Ammonia. Sub-oxide of Silver. Bromide of Ammonium.

$$\overbrace{Ag_3Br}^{\text{Sub-bromide of Silver.}} + \overbrace{NH_4O}^{\text{Ammonia.}} = \overbrace{Ag_3O}^{\text{Sub-oxide of Silver.}} + \overbrace{NH_4Br}^{\text{Bromide of Ammonium.}}$$

When pyrogallic acid is added to the ammonia, the sub-oxide is reduced to the metallic state. Thus :—

Sub-oxide of Silver. Pyrogallic Acid. Silver. Oxygenated Pyrogallic Acid.

$$\overbrace{Ag_3O}^{\text{Sub-oxide of Silver.}} + \overbrace{Pyr}^{\text{Pyrogallic Acid.}} = \overbrace{3Ag}^{\text{Silver.}} + \overbrace{PyrO}^{\text{Oxygenated Pyrogallic Acid.}}$$

Thus it is manifest that in alkaline development there are two actions,—the sub-bromide is first reduced to the state of sub-oxide, and this again is reduced to the metallic form.

Pyrogallic acid alone is also a developer, but it will be found that in nearly every case the plates developed by it (without any addition of a retarder) contain minute traces of nitrate of silver, or organic salts of silver (such as albuminate). Presumably, the action of the pyrogallic acid in this case is precisely similar to that of wet plates. If it can be proved that a dry plate will develop by this method, when it is certain that all such salts of silver are absent, then a pyrogallic bromide must be formed,—

Sub-bromide of Silver. Silver. Pyrogallic Bromide.

$$\overbrace{Ag_3\,Br}^{\text{Sub-bromide of Silver.}} + Pyr = \overbrace{3Ag}^{\text{Silver.}} + \overbrace{Pyr\,Br}^{\text{Pyrogallic Bromide.}}$$

Every dry plate will develop like an ordinary wet plate; that

is, if free nitrate of silver be added to the developer, the image will be formed by the atoms of silver (reduced from the *developing solution*) being attracted by the *sub-iodide and sub-bromide*. Thus the image will be built up *on* the film, and not in it.

From the foregoing it will be apparent that for alkaline development the presence of iodide in the collodion is not necessary, as all that forms the image is the reduced sub-bromide, the sub-iodide remaining unaltered. The presence of an iodide is, however, useful, as it prevents "halation," or blurring of the image.

When the image is to be developed by the addition of silver to the oxidizable agent, the iodide is as useful as the bromide.

Dry plates nearly always require a longer exposure than do wet. This arises partly from the fact that the particles of iodide and bromide are in a less mobile state in the former than in the latter. Another reason is, that the preservative has not such a strong affinity for the liberated iodine as has the nitrate of silver.

The keeping qualities of dry plates are dependent upon causes which have not been *fully* explained. It has been found that certain processes give sensitiveness in a plate for an almost unlimited time, whilst others give a film sensitive only for two or three weeks or less. This depends on two causes:—1st. On the nature of the preservative used. If it have the power, whilst in contact with the silver, of forming an organic compound which is insensitive to light, the longer the two are in contact the more insensitive will the plate become. 2nd. On the completeness of the desiccation. Moisture aiding chemical action, the dryer the film the longer will the plate remain sensitive.

MANIPULATION OF DRY PLATE PROCESS.

Dry processes may be divided into two classes:—1st. Those prepared by the aid of the bath. 2nd. Those prepared by an emulsion of the salt of silver in the collodion. Of the two, the writer prefers the former, as there are difficulties in getting the certainty of a perfectly clean negative with the second, though, doubtless, with greater experience, these difficulties will be overcome. Of the first-named the gum-gallic process is to be recommended, on account of its simplicity and the delicacy

of the results: another advantage of it is, that iron development can be used with it, which gives certain qualities which seem to be unobtainable, as a rule, by any other method. Of the remaining of these processes which are to be described, the collodio-albumen is much used by many dry plate workers.

THE GUM GALLIC PROCESS.

This process was first introduced by Mr. R. Manners Gordon, and in his hands, and those of many experimentalists, has proved of great value. The negatives are possessed of remarkable delicacy, and an appearance similar to wet plates.

Cleaning the Plate.—The plates must be thoroughly cleaned as for the wet process. It will be found necessary (in order to prevent the film slipping during development) to apply either an edging of albumen or india-rubber solution, or else to coat the whole of the surface with these preparations.

For any plate not exceeding $8\frac{1}{2} \times 6\frac{1}{2}$ the edging is sufficient, and, in fact, is to be preferred. If albumen be applied—

Albumen	1 ounce
Water	10 ounces

should be the strength used. This should be well shaken for five minutes in a stoppered bottle, and, when clear, a camel's hair paint brush should be employed, to give an edging about one-eighth of an inch in breadth. This will speedily dry, and the plate will then be ready for coating. Care should be taken that the albumen be not passed over any portion of the plate which will not be covered by the collodion film. If this precaution be not taken, the sensitizing bath will become contaminated by the organic matter.

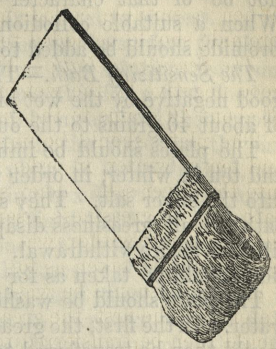
If india-rubber be used, the same formula will answer as for coating the whole surface. It is perfectly harmless in the bath, not affecting the silver salt. When a preliminary *coating* of albumen is determined upon, the following formula should be adopted:—

Albumen	1 ounce (white of one egg)
Water	50 to 100 ounces
Liquor ammonia	5 drops*

The albumen and water should be well shaken together in a bottle for five minutes, and then filtered through fine filter paper

* Three or four drops of commercial carbolic acid may be substituted for the ammonia.

or well washed tow. The funnel should be lowered nearly to the bottom of the beaker into which the albumen is filtered, to prevent the formation of air-bubbles



The most convenient method of applying albumen is that employed by Mr. Valentine Blanchard. A brush is made of swan's down calico, as follows :—A strip of glass, about six inches long by two broad, should be procured, and round one end should be attached, by thread or india-rubber band, a double fold of swan's down calico. This brush should be dipped in the albumen, and the excess squeezed out against the beaker. The plate should then be brushed smoothly down the surface in parallel lines to within one-eighth of an inch of its edges, set up to dry on blotting-paper, and protected from dust. When dried (which it should be spontaneously), the plate will be ready for the collodion.

Warming the plate previous to coating with collodion is of service, preventing blisters. Some prefer to flow the plate with the albumen solution. This is best done on a plate which has been well cleaned but not polished, and which has been subsequently moistened with distilled or rain water. Whilst still wet the albumen should be flowed over the surface, as in coating a plate with collodion. The surplus fluid should be returned to the stock bottle through the filter. If this plan of giving a substratum be adopted, the solution should only contain fifty ounces of water to one ounce of albumen.

The formula for the india-rubber solution, which should be poured over the cleaned and polished plate, is

India-rubber	1 grain
Chloroform, commercial	1 ounce

Or,

India-rubber	1 grain
Benzole (rectified)	1 ounce

The defects of this solution will be noticed at the end of the description of this process.

Collodion.—The collodion to be recommended is such as will

give by the wet process a brilliant and intense negative. The film should not be horny, whilst, on the other hand, it should not be of that character which admits of being easily torn. When a suitable collodion has been found, an extra grain of bromide should be added to each ounce.

The Sensitizing Bath.—The bath should be such as will give a good negative by the wet process. It should be of the strength of about 40 grains to the ounce.

The plates should be immersed for seven minutes in summer, and ten in winter, in order to convert the whole of the bromide into the silver salt. They should be worked up and down in the bath till all greasiness disappears, and should then be left quiet till just before withdrawal. The same precautions in this operation should be taken as for wet plates.

The plate should be washed in two dishes of distilled or rain water. In the first, the greasiness should be washed off; the plate should then be transferred to the second, where it should remain till the next plate is ready for washing. It should next be transferred to a trough holding a considerable quantity of water, and be left for half-an-hour.* By this long washing the plate is freed of its last traces of the free nitrate of silver, which will ensure its keeping qualities. Finally, the plates should be rinsed with a small quantity of distilled or rain water; they will then be ready for the preservative.

The composition of the preservative is as follows:—

No. 1	Gum-arabic	20 grains
	Sugar-candy	5 ,,
	Water	6 drachms
No. 2	Gallic acid	3 grains
	Water	2 drachms

No. 2 is prepared with the aid of heat, and is then mixed with No. 1 in the proportions indicated.

To filter this, great care should be taken to select a thin filtering paper which is free from iron. The presence of this impurity will be indicated by the solution turning an inky colour. It will be found to run through the paper better if the solution be kept warm.

The gum-arabic should be "picked;" that is, all yellowish

* If the plates are required to be kept but a short time (say three or four weeks), a minute's washing under the tap is sufficient. The plates will be rather more sensitive than if the washing be prolonged.

lumps should be rejected, nothing but the white being used. Dealers supply the gum as picked if insisted upon.

The water used should be distilled, rain, or purified. If it contain iron in appreciable quantity, it is fatal to success.

The preservative is applied by floating on the surface for about a minute. It is a good plan to allow the solution from one plate to flow back into the cup, and use this for a first flooding of the next plate, pouring it immediately away, and then applying fresh. By this means dilution from the water on the surface of the film is avoided. The plate is lastly drained, and placed in the drying-box. If the drying-box described in "Apparatus" be not available, any ordinary light-tight and large box may be converted temporarily into one. Only one corner should be allowed to rest on two or three thicknesses of blotting-paper. The plates should dry spontaneously, and then be placed in plate boxes. If the plates, previous to exposure, appear dull, they should be dried by artificial heat before being placed in the dark slides.

Exposure.—Great latitude in exposure is admissible; it should rarely be less than four times, nor more than twenty times, that required for wet plates under ordinary circumstances.

Blurring.—Blurring, or halation, in a negative is a kind of "halo"-effect, which is seen on a deep shadow when in close contiguity to an intensely high light. Thus, when dark trees are taken against a bright sky, the light of the latter appears to be partially continued on to the tops of the former. This is caused by the reflections and re-reflections of the light from the back surface of the plate. If the reflections can be tinged with a non-actinic colour, their action will be *nil* on the film. This non-actinic colour can be given to the reflected light by coating the back of the plate with some non-actinic colour, such as gamboge, burnt sienna, &c.; or a piece of damped carbon tissue, as proposed by Dr. Vogel, may be pressed against the back of the plate, which will give the same result. One advantage of the latter mode is, that the tissue may be used over and over again. Should it be proposed to coat the back of the plate, the following will be found to answer well:—

Powdered burnt sienna	1 ounce
Gum	1 ,,
Glycerine	2 drachms
Water	10 ounces

This may be brushed on to the back with a broad hog's-bristle brush. Gum-gallic plates require no backing if suitable collodion be used.

Development.—The most satisfactory development for these plates is by acid, iron, and nitrate of silver solutions. The formula is—

No. 1	Gelatine	... 64 grains
	Glacial acetic acid	... 2 ounces
	Water	... 14 ,,
No. 2	Protosulphate of iron ...	... 30 grains
	Water	... 1 ounce

Half the quantity of the water in No. 1 should be taken, and the gelatine allowed to soak in it till it be thoroughly swelled (any kind of fresh gelatine will answer). The remaining half of the water should be added in a boiling condition, which will cause solution. The acetic acid should next be added, and the whole allowed to cool.

One part by measure of No. 1 should be mixed with three parts of No. 2, and then filtered. It is inexpedient to mix more than is necessary for one or two days' use, as the iron undergoes oxidation. No. 1 will keep indefinitely, whilst No. 2 should be made as required.

To every drachm of developer used, one drop of a solution of nitrate of silver (30 grains to the ounce) should be added just previous to the application to the plate.

To develop the image, the backing (if any) must first be entirely removed with a damp rag, or peeled off in the case of carbon tissue. The plate should then be immersed in a dish of water of not less than 65° Fahr. for two or three minutes, to soften the gum, and finally rinsed under the tap. The developer should be now flowed over, and, if properly exposed, the image will begin to appear almost immediately. As it appears, more silver solution must be added, by two or three drops at a time, till the whole of the detail is visible. The film must next be well washed, and intensity gained by the ordinary pyrogallic acid intensifier and silver solution. The negative should have all the characteristics of a wet plate if properly manipulated. Should it be inferred that the plate is over-exposed, more of No. 1 may be added to the developer. It is important that the silver solution be added to the developer previous to flowing over the plate. If the latter be applied alone, and then

silver be added, the resulting negative is liable to be granular in appearance.

The plate may be fixed either by hyposulphite or by cyanide, as for wet plates.

Alkaline development, as described for Col. Wortley's plates, may be employed. Some recommend this method if the plate be kept for a long period (say a month) between exposure and development.

DEFECTS IN THE NEGATIVE.

Blisters.—If blisters make their appearance, it is probable, if the substratum be of albumen, that the solution is not sufficiently dilute. With some kinds of india-rubber blisters always appear.

Transparent markings may be caused by handling the plate with warm fingers before immersion in water previous to development. The corners of the plate alone should be touched.

Large opaque spots may be caused by allowing a warm finger to touch the plate during development.

A transparent edge will be caused by allowing the whole length of the edge of the plate to rest on blotting-paper when drying in the drying-box.

A lack of density is caused by the collodion being too thin, requiring more pyroxyline; by an insufficient quantity of iodide; and by insufficient sensitizing in the bath.

Lines may be caused by a stoppage in the wave of developing solution, by removing the plate in the drying-box previous to complete desiccation, or by an uneven flow of the preservative over the film.

Black spots on the film may be due to the india-rubber substratum, and to dust on the plate.

Transparent spots may be met with when photographing near the sea. They are probably due to the chloride of sodium which is held in suspension in the air. They rarely occur if the plate have been thoroughly dried finally by artificial heat a short time before exposure.

Pinholes may be caused by the solution of silver added to the developer dissolving out iodide from the film. If the preservative be not well filtered such defect may likewise occur.

THE COFFEE PROCESS.

There have been various modifications of this process; the best, as far as experience has taught, is that of M. de Constant. It is thoroughly reliable, and the plates prepared by this method keep well, and give soft negatives.

The collodion to be recommended for this process, according to M. de Constant, is Mawson's, with the addition of two grains of bromide of cadmium to the ounce. Thomas's collodion yields equally fine results. If collodion be home-made, the pyroxyline should be manufactured at a high temperature in the acids, and may be known in commerce by its yellow appearance, and by being found to separate in hard rather than in fibrous particles.

The plate is coated and the film sensitized in the ordinary way. After remaining in the bath for some three to five minutes it is taken out and plunged into a bath of distilled water: a flat dish answers perfectly. Care must be taken that there is no stoppage in immersing the plate; if there be, greasy marks will be seen on the developed plate. The plate should remain in this bath till all greasiness has disappeared. It should then be transferred to a second dish, and left there till it is time to coat it with the preservative solution. Ordinary water answers in lieu of the distilled, if it do not contain much of the alkaline chlorides or iron.

The preservative is formed as follows:—

No. 1	Boiling distilled water	5½ ounces
	(Mocha) coffee	½ ounce
	White sugar	90 grains
No. 2	Distilled water	5½ ounces
	Gum-arabic	90 grains
	Sugar-candy	20 ,,

No. 1 is allowed to cool in a well-corked bottle, and both solutions should then be filtered and mixed. It is found convenient to pound the gum-arabic and sugar-candy in No. 2 before adding the distilled water.

The film may be coated with the preservative in the ordinary manner, two applications of a minute's duration being necessary. It is *better* to use a flat dish to *immerse* the plate in for two minutes, as evenness of coating is thereby ensured. The plate should be then placed on end, upon folds of blotting-paper, to drain, previous to placing it in the drying-box.

The same precautions for drying are to be observed in this as in the last process. When thoroughly dry the surface of the film assumes great brilliancy, and exhibits neither stain nor fog by transmitted light. If a cloudy aspect be on portions of the film, a heated flat iron passed over it, an inch from the surface, will restore the brilliancy, and the plate will be fit for use.

M. de Constant states that the exposure required for these plates is three times the length required for wet plates, under precisely similar circumstances. It is better to give six times the exposure, as the development is easily controlled in a slightly over-exposed picture. In bright sunshine, it is stated that longer exposure is requisite than in cloudy weather.

The plates being very transparent, blurring of the image is sometimes apparent. In such a case "backing" (see page 59) must be given.

Before development the plate should be covered with, or else immersed in, rain or good ordinary water for three or four minutes, and kept in motion. The water should then be drained off. For an $8\frac{1}{2}$ by $6\frac{1}{2}$ plate the following must be flooded over the plate: —

*Saturated solution of carbonate of ammonia...	8 drops
Water...	4 drachms.

This is worked over the plate till the image begins to appear, or till there is no further action caused by it. Return this from the plate into the developing-cup, in which shall have been dropped from one to two drops of the following solution: —

Pyrogallic acid...	30 grains
Alcohol...	1 ounce

The ammoniacal water, with this solution added, should be now swept over the plate in a manner similar to that employed in developing a wet plate, as its action is extremely rapid. The image will now appear fully by reflected light, but be barely visible by transmitted light. The action of this solution must be continued till every possible detail in the shadows is brought out. The image may now be intensified by the ordinary pyrogallic intensifier (page 22); but it will always by this method

* Four drops of concentrated liquor ammonia may be substituted.

appear transparent. To prevent this, M. de Constant uses the following before the final pyrogallic intensification:—

Ammonio-sulphate of iron	...	...	45	grains
Sulphate of copper	...	...	45	,,
Citric acid	...	...	45	,,
Water ...	..	...	$3\frac{1}{2}$	ounces

It will remain in good condition for a considerable length of time.

Two or three drops of a 20-grain solution of iron may be added to this after the first application. On the second application, the negative becomes of a colour resembling that of a wet plate. The ordinary intensifier should be used after this. If the negative tends to become solarized (*i.e.*, to turn a reddish colour in the shadows) it should be fixed at once, and intensification take place afterwards.

The methods of development given for England's process and for the Tannin process also answer satisfactorily.

Either hyposulphite of soda, or a weak solution of cyanide of potassium, may be used for fixing the image. If the latter agent be used, a few drops of acetic acid should be dropped into it before application; this prevents blistering.

THE NEGATIVE.

The defects in this process arise chiefly from want of proper manipulation.

Spots, like grease, on the plate arise from washing the sensitized plate, on withdrawal from the bath, under the tap with a heavy stream of water. Unless the plate be immersed, or the stream of water flow continuously over the whole film, the spots may be looked for.

If the germ of the egg, or a portion of the yolk, be left in the albumen, opaque spots result.

Want of detail may arise from the use of a *very* old collodion containing but little bromide in it, from under-exposure, or neglecting to bring out all detail during development.

Transparent markings arise if the plate be exposed before it be thoroughly dry.

If the coffee be not drained off by filter or blotting-paper, capillary attraction causes it to run up the plate, and dry in ridges. This will cause markings.

THE COLLODIO-ALBUMEN PROCESS.

The plate must be cleaned, and a substratum given as described at page 56 for the gum-gallic process, unless the collodion be of such a character that it will stick to the glass plate most tenaciously.

The collodion should be very old and powdery. The dregs of different samples may all be thrown together, and though almost entirely insensitive for the wet process, it will be found to be no drawback for this; even collodion that sets opalescent is suitable. Mr. Mudd, whose exquisite landscapes are produced by this method, advises that it should contain no bromide; other workers do not insist on this condition.

The ordinary negative bath may be used. The plate, being sensitized as usual, is washed thoroughly till *all* the free nitrate of silver is removed.* The plate is then flowed over with the following:—

Albumen	8 ounces
Ammonia	2 drachms
Iodide of potassium	50 grains
Bromide of potassium	10 grains
Water...	$2\frac{1}{2}$ ounces

This operation should be repeated twice, taking fresh solution every time. (The salts are first dissolved in the water, next the ammonia added, and then the solution mixed with the albumen. The whole is then beaten to a froth, and allowed to settle. The clear liquid should then be decanted or syphoned off for use. The eggs should be fresh if possible. Before use, the solution should be filtered through a piece of sponge plugged into a funnel).

The plate is next slightly drained, and set up to dry. At this stage it is quite insensitive to light if no bromide be present in the collodion, and will keep indefinitely. Before use, resensitizing must take place. A bath must be prepared made as follows:—

Nitrate of silver	30 grains
Glacial acetic acid	$\frac{1}{2}$ drachm
Water	1 ounce

* It may be immersed in a five-grain solution of iodide of potassium to secure this result.

Into this the dried plate must be dipped, and be allowed to remain in it for at least one minute—ten will not hurt it. After withdrawal it must be thoroughly washed, and then be set up to drain. When the excess of water has been absorbed it is placed in the drying box, and allowed to dry spontaneously.

Plates thus rendered sensitive will keep for a week in hot weather, but longer in cold.* The newer the plates the better will be the result. They will keep almost indefinitely after exposure, which is of great advantage to the tourist.

The required exposure is long—in fact, it is almost impossible to over-expose; at least ten times the exposure of an ordinarily sensitive wet-plate should be given, whilst twenty times would be better.

To develop, wash the plate thoroughly, and flow over it—

Pyrogallic acid	3 grains
Water	1 ounce

After a few minutes the outline of the sky will appear by reflected, though nothing will be visible by transmitted, light. Bring out *nearly* all the detail, but leave a little to be done by the subsequent intensification. A considerable quantity of unaltered iodide should be visible in the image. If over-exposure be suspected, the image may be brought out by the acid developer to be described (page 68), whilst if under-exposure is probable, the pyrogallic acid in the above may be increased to six grains, or even more. To bring up the image to printing density, the following is applied with three or four drops to each ounce of a solution of nitrate of silver (30 grains to the ounce of water):—

Pyrogallic acid	2 grains
Citric acid	½ grain
Water	1 ounce

During the operation a slight deposit may take place on the surface of the film. This can be removed by a tuft of cotton wool. When the image seems of proper strength, wash, and fix with hyposulphite of soda (see page 79).

An under-exposed picture may be forced up by using the

* If a saturated solution of gallic acid be applied after the final washing the plates will keep sensitive for months.

plain pyrogallic solution warm, and, as before mentioned, by increasing its strength, and also by alkaline development (page 72).

The sky in the pictures produced by this method is rarely sufficiently opaque. Painting out must be adopted, an operation tedious, and often unsatisfactory.

The defects in these negatives are those already pointed out for those produced by the gum-gallic process, in addition to those due to the albumen preservative.

ENGLAND'S COLLODIO-ALBUMEN PROCESS.

A very useful modification of the foregoing has been introduced by Mr. England. The plate is cleaned, sensitized, and thoroughly washed. It is then flowed over with albumen, the white of one egg to one ounce of water in cold weather, and two ounces of water in hot weather. This is well shaken up in a bottle, till the albumen is thoroughly incorporated with the water, and filtered through sponge. The plate is next rinsed to free it from superfluous albumen, and a silver solution (made similarly to the bath, acidified with acetic acid in the last process) is flowed over the film without any stoppage, and allowed to remain on it for a minute. It is then thoroughly washed, and allowed to dry spontaneously. The exposure is about the same as for a gum-gallic plate. The development is conducted as for the collodio-bromide process.

HOT WATER PROCESS.

The last process may be varied by immersing the plate, immediately after it is floated with the preservative, in boiling water, to coagulate the albumen, and flowing over it a saturated solution of gallic in water, and setting up to dry. The development may be carried on as above, or by the alkaline method.

TANNIN PROCESS.

With this process bromo-iodized collodion is to be used. The plates require a substratum or an edging. After well sensitizing they are thoroughly washed in distilled water, rinsed under the tap, and finally with distilled water. The preservative—

Tannin (pure)	...	...	... 10 to 15 grains
Distilled water	...	...	... 1 ounce

is then flowed over them. (The addition of gum ten grains, and sugar five grains, is recommended by some, but the advantage is not very apparent.)

The exposure required is about one and a-half times that of a gum-gallic plate.

To develop a plate, it is first flooded with spirits of wine and water, and then washed.

The developing solutions are—

No. 1.	Pyrogallic acid	144 grains
	Alcohol	2 ounces
No. 2.	Nitrate of silver	60 grains
	Citric acid	60 „
	Distilled water	3 ounces
Take of	No. 1.	16 drops
	No. 2.	8 „
	Water	1 ounce

Flow this over the plate till the detail is well out, when five or six drops more of No. 2 must be added to give intensity. These plates are sometimes most satisfactory, at other times they are full of pinholes and stains. A good batch will keep well for two or three months.

A TEA PROCESS.

Of all dry processes, the tea process is the most charming, when exposure can be given to the plates within two or three days of preparation. They can be developed by the gum-gallic, iron, or alkaline developer. They possess a beauty not obtainable by most processes.

The plate is coated with a bromo-iodized collodion, sensitized as usual, a preliminary coating or edging having been given to it. After thorough washing it is *immersed* in an infusion of tea. This latter is prepared by pouring about ten ounces of boiling water on half-an-ounce of good black tea. After standing one or two hours it is filtered, and is ready for use. It will not bear the addition of either gum or sugar. The plates require about three times the exposure of wet plates, and should be developed within twenty-four hours afterwards.

A BEER PROCESS.

This process is most simple and efficient. To each ounce of ale or beer add one grain of pyrogallic acid, and flow over a well washed film. When dry, it can be developed by plain pyrogallic acid (see page 71), or by the strong alkaline development (page 72); a substratum of albumen or india-rubber is required.

THE COLLODIO-BROMIDE PROCESS.

The collodio-bromide is different to any process hitherto described. The use of the nitrate of silver bath is avoided, and, with it, many of its inherent defects. No iodide is employed in the collodion; it is merely bromized, though Mr. Carey Lea, in a modification of the process, adds a chloride. The bromide of silver is formed by the addition of nitrate of silver, either in powder or else dissolved in alcohol, to the collodion. An emulsion, as it is termed, of bromide of silver takes place in the collodion, and is held suspended by it. The plates may be prepared either with an excess of soluble bromide for the amount of silver added, or *vice versa*. The following gives a slight excess of soluble bromide.

The pyroxyline, prepared as given at page 10, may be used for the preparation of the collodion, or any good commercial sample will answer; but that prepared at a higher temperature than usual is recommended by Mr. Cooper. This gentleman's formula for the collodion stands as follows:—

Ether ·730	4 ounces
Alcohol ·805	2 ,,
Bromide of cadmium... ...	40 grains
Bromide of ammonium ...	24 ,,
Pyroxyline	40 to 50 ,,

Twelve fluid drachms of this are measured into a four-ounce bottle. Having fused a sufficient quantity of nitrate of silver for the purpose, and powdered it very finely, weigh out 34½ grains, and place it in the bottom of a clean test-tube. Pour 3 drachms of alcohol, ·825, upon it, and raise it to the boiling point, shaking the silver in the alcohol occasionally. When cooled, pour off the dissolved nitrate of silver from the undissolved nitrate into the collodion, little by little, shaking between each addition. Next add 3 drachms of alcohol to

the undissolved portion, boil, let cool, and add as before. It will be found that the whole of the silver is dissolved, and the emulsion of bromide of silver will be complete, though there will be an excess of 11½ grains of nitrate of silver, 23 being sufficient for the 12 drachms; twelve drachms of the plain bromized collodion are next added, and here the bromide is in excess. In this condition the collodion can be kept for any length of time. When required for use, 11½ grains of silver, dissolved in 2 drachms of alcohol, are added in the method described above. After standing about an hour, the collodion is fit for use. If requisite, it may be filtered through tow which has been thoroughly boiled in soda, and subsequently well washed. By adding the nitrate of silver in excess at first, the whole of the bromide is converted into bromide of silver, and a small portion enters into chemical combination with the pyroxyline of the collodion. The last addition of the silver, therefore, leaves the bromide in *slight* excess, which is desirable for clean working.

The old method of dissolving the nitrate of silver in the collodion itself is much less satisfactory, and it is uncertain how much of the nitrate of silver is left undissolved and is filtered out.

Another method of adding the silver, which was suggested by a correspondent in the *British Journal of Photography*, is to convert it all into carbonate. The silver from the nitrate solution is precipitated by carbonate of soda, filtered, washed, and dried. The amount of carbonate of silver necessary to add for every 10 grains of anhydrous bromide of cadmium is *very nearly* 10 grains (for other bromides see p. 12), the amount being arrived at by the amount of bromine present in each salt. The carbonate is added to the bromized collodion, and nitric acid is added very cautiously till no more effervescence is manifest. The nitric acid liberates the carbonic acid, forming nitrate of silver, which, in its turn, combines with the bromide present. By this method either an excess or the reverse of nitrate of silver can be given to an emulsion, and the resulting film seems less liable to spots.

Another method, which has its advantage, is to prepare bromide of silver from an aqueous solution of any bromide. A solution of a weighed quantity of any bromide is made, and nitrate of silver in solution is added till no further precipitation

of bromide of silver takes place. The precipitate is well washed with distilled water, and finally with alcohol, dried, and then added to plain collodion, and violently shaken for a few minutes. If one grain of chloride of silver be added to each ounce of collodion, an alcoholic solution of nitrate of silver may be added to the latter, giving, of course, an excess of silver in the emulsion. If no chloride be added, two or three drops of a 20-grain solution of bromide of cadmium should be added to every 10 ounces of the collodion.

If collodio-bromide be fully sensitized with silver, it is found that in three or four days' time it loses its sensitiveness. This may be avoided by adding each time, after preparing plates, a certain quantity of the bromized collodion to the residue, and re-sensitizing it, as before, when required.

If the collodion be horny, the alcohol containing the nitrate of silver may be added boiling.

The plate is coated in non-actinic light, in the ordinary manner. When the film has set properly, immerse the plate in pure water until the greasiness has disappeared. Withdraw it from the dish, and then immerse in a solution made as follows:—

(Mr. Cooper's Preservative.)

Gum-arabic	15 grains
Tannin...	4 „
White sugar	4 „
Distilled water	1 ounce

Or,

(The Liverpool Dry-Plate Company's Preservative).

Tannin...	15 grains
Alcohol	15 minims
Water	1 ounce

The same preservative, containing salicine, as used in Col. Stuart Wortley's process, is also applicable.

Collodio-bromide plates are usually very transparent, and consequently require a backing; the same as given at page 59 may be given. Mr. Cooper has suggested the use of aurine in the collodion to prevent blurring. He makes a solution of 1 drachm of aurine to 1 ounce of alcohol. All impurities are precipitated, and about 30 drops of the solution are added

to each ounce of collodion. With alkaline development, if not previously dissolved out, the colour is apt to change to a deep red. This is got rid of by washing with an alkali (liquor-ammonia answers well) or spirits of wine after fixing.

Alkaline development is usually employed, and for this method it is necessary to have the following solutions ready:—

No. 1	Pyrogallic acid	3 grains
	Water	1 ounce

(This will not keep long, but should be made when required.)

No. 2	Carbonate of ammonia	1½ drachms
	Water	1 ounce

Or,

No. 2.	Liquor ammonia	1 part
	Water	12 parts
No. 3	Bromide of potassium	1 grain
	Water	1 ounce
No. 4	Nitrate of silver	20 grains
	Citric acid	25 „
	Water	1 ounce

Nos. 2, 3, and 4 will keep indefinitely.

The film should be flooded with alcohol and water* (equal parts of each being used), and worked over it for a couple of minutes, till the surface is softened. If aurine have been used, the alcohol dissolves it out, leaving the film free from colour. If there be "backing," it should be removed directly after flooding with the alcohol, and before the film is washed with water. By this procedure there is no danger of the colouring matter adhering to the film. (This is the plan recommended by Dr. Dawson in the directions for the development of his plates.) They should then be well washed under the tap. If there be every reason to suppose that proper exposure have been given, make a developing mixture in the following proportion:—

No. 1	1 drachm
No. 2	1 drop
No. 3	1 „

* This may be used over and over again. Methylated spirits may be substituted for the pure alcohol.

Sufficient should be taken to well cover the plate. Nos. 2 and 3 should be first dropped into the developing cup, and finally No. 1 is added. (The necessity of stirring is prevented by this procedure.) Flood this over the plate. The image, if everything be *en règle*, should appear quickly, and the developer should be worked over the plate till all detail appears by reflected light. When this happens, another drop of No. 2 to each drachm should be dropped into the measure, and the solution poured back on to it as before, and the intensification with the stronger ammoniacal solution proceeded with. The intensity will gradually be increased, and it may happen that No. 4 is not required, the requisite density being obtained without it. Should the density not be sufficient, one drop of No. 4, with a drachm of No. 1, may be mixed, and intensification takes place in the ordinary manner. In the writer's experience, the colour and printing qualities of all negatives by this process are improved by even a slight application of the intensifier. This opinion coincides with that of Mr. Cooper.

Should the negative flash out at once on the application of the first developer, it is a sign of over-exposure of the plate. The developer should immediately be returned to the cup and the plate washed. Two drops extra of No. 3 must be added to the developer, and the development proceeded with as before. The bromide of potassium keeps the shadows bright, and acts as a retarder; so much has it the latter qualification, that if a large quantity be added the plate will refuse to develop at all. It is better to fix an over-exposed picture immediately the detail is all out, and intensify with pyrogallic acid and silver afterwards.

If traces of the picture refuse to appear after an application of the primary developer for three or four seconds, a fresh developer should be made up similar to the above, *omitting* the bromide of potassium. The picture will probably appear satisfactorily when this course is adopted. When the detail is well out, the intensification should be carried on as given above.

The negative should be fixed with weak cyanide or hypo-sulphite of soda.

MR. HENRY COOPER'S COLLODIO-BROMIDE PROCESS WITH A LACTATE.

Mr. Cooper has modified the above general formula to attain a greater amount of sensitiveness. The pyroxyline used is made at a high temperature, and can be obtained from most photographic chemists. The collodion is made as follows:—

*Anhydrous bromide of cadmium	...	52 grains
Anhydrous chloride of calcium	...	8 „
Pyroxyline	about	45 „
Ether, refined	...	4½ ounces
Alcohol	...	2½ „

To form the emulsion, take fourteen grains of powdered fused nitrate of silver, and place it in a tiny glass flask. Pour upon it seven minims of distilled water, and dissolve by heat. Now pour in gently three drachms of absolute alcohol, and again warm over the spirit lamp until all the nitrate is taken up. Whilst the solution is still warm add it gradually to seven drachms of the bromo-chlorized collodion, previously measured into a clean and dry stoppered bottle. The only precaution to be observed is, to add a very little of nitrate solution at a time, shaking violently between each dose. Finally, add five *drops*, not minims, of syrupy lactate of ammonia. The emulsion may be used in about twelve hours, but gains in sensitiveness by keeping somewhat longer.

After coating with emulsion, the plate is rinsed in two changes of distilled or soft water until the greasy lines disappear, and is then soaked for two minutes in a bath or dish of the preservative, drained, and dried in the usual manner.

The preservatives he recommends are Col. Wortley's salicine, and the following:—

1	Tannin	60 grains
	Water	1 ounce
	Carbolic acid	1 drop
2	Gallic acid	48 grains
	Alcohol	1 ounce

* Taken from Mr. Cooper's communication to the *Photographic News* and *British Journal*.

Of these, take of—

No. 1	1 ounce
No. 2	½ ,,
Sugar	50 grains
Gum arabic	50 ,,
Water	9 ounces

Nos. 1 and 2 are stock solutions.

The development is the same as given above, or Col. Wortley's formulæ will answer.

URANIUM DRY PLATES.

Col. Stuart Wortley has recently experimented largely and fully in the emulsion process, and he finds that the addition of the nitrate of uranium to an emulsion adds to the sensitiveness of the plates, and renders the tendency of the bromide of silver with an excess of nitrate of silver to deposit to be much lessened. The uranium likewise restrains "fog" or veiling of the image.

It should be here stated that an excess of nitrate of silver in this emulsion renders the dry plates very rapid, nearly approaching that of wet. The following is taken from a paper read by Col. Wortley before the Dry Plate Club in April, 1872.

The plain collodion is made with pyroxyline prepared at a high temperature.

The emulsion is made as follows:—

Plain collodion...	1 ounce
Anhydrous bromide of cadmium ...	7 grains
Nitrate of uranium	30 ,,
Nitrate of silver	13 ,,

The nitrate of uranium should be pure, and *very slightly* acidified with nitric acid. The uranium salt and bromide of cadmium should be dissolved in the collodion, and the nitrate of silver added as directed before. The plate should have a substratum, and be coated as usual; when set, it is washed in distilled water till all greasiness disappears, when any of the usual preservatives may be flowed over it. Preservatives containing sufficient gum to give a protection to the film tend to cause blisters on development. Col. Wortley recommends the following as giving freedom from this annoyance.

The following stock solutions are prepared:—

No. 1.	Salicine, enough to make a saturated solution in distilled water.	
No. 2.	Tannin	... 60 grains
	Distilled water ...	... 1 ounce
No. 3.	Gallic acid	... 48 grains
	Alcohol	... 1 ounce

To make the preservative take of—

No. 1.	... 2 ounces
No. 2.	... 1 ounce
No. 3.	... ½ ,,
Sugar	... 40 grains
Water	... 7 ounces

This preservative may be used over and over again with occasional filtering. The plates are best immersed in it.

Aurine must be introduced into the plain collodion, or else a backing must be given, to prevent blurring.

For the development of these plates, the following solutions must be prepared.

1.	Carbonate of ammonia* ...	... 64 grains
	Water...	... 1 ounce
2.	Bromide of potassium ...	... 4 grains
	Water	... 1 ounce
3.	Pyrogallic acid	... 96 grains
	Alcohol	... 1 ounce

With any preservative which is soluble in alcohol the plates should be flowed over with spirits of wine diluted with twenty to thirty per cent. of water (which may be used over and over again). When well soaked into the film and the aurine removed, a thorough washing must be given.† Then mix the developer in the following proportions:—

No. 1....	... 60 minims
No. 2....	... 60 ,,
No. 3....	... 15 ,,
Water (distilled)	... 2 drachms
Spirits of wine	... ½ drachm

* Liquor ammonia twenty drops, water one ounce, may be substituted if necessary.

† If the plates have a "backing," it should be removed previous to the washing (see page 72).

The plate is covered with this in the usual manner, and worked about. As the detail appears, more ammonia (No. 1) is added with half the quantity of bromide (No. 2).

The following paragraphs are from Colonel Wortley's directions for development, and are worthy of attention :—

"According to the way in which the plate comes out, you will see whether the exposure and development have been right. If the plate flashes out at once on the application of the developer, it is over-exposed, and more bromide should be added at once, to control the development. If, on the contrary, the negative remains for thirty or forty seconds without the picture appearing, it will be a sign of under-exposure, and from ten to twenty drops of No. 1 may be added to the developer.

"It may be that some pictures taken in a weak light may require much forcing: if so, remember to add the same proportion of No. 2 with No. 1. If the plate is very clear, and devoid of detail, it may be permissible to add a few drops of No. 1 without any No. 2. Bear this rule ever in mind. If you wish the plates to work more quickly, reduce the bromide in the developer; if there is any tendency to fog, increase the bromide or decrease the exposure.

"On any dark spot in the picture where there is a dark shadow pour the solution constantly, which will soon bring out the detail. It is frequently very useful to pour the developer off the film, and leave the negative on the developing-stand, with no solution on it, for a minute or two at a time, as that assists to bring both detail and density. In pouring off the developer, rock the plate, so that the former does not run in lines. I may here note, that when a plate has had too short an exposure or the subject badly lit, it is well, if the first lot of developer appears to have exhausted its action, to make up a second quantity, by adding to the four drachms of water ten drops of No. 3, thirty drops of No. 1, and twenty drops of No. 2; continuing to add No. 1 freely with the same proportion of No. 2 till the negative is finished."

It is probable that this development will give insufficient density, unless the plates be prepared with an excess of bromide, or with some organic salt of silver (as in the case with Colonel Wortley's new plates). The *ordinary* pyrogallic acid intensifier may be employed with a thirty-grain solution of silver.

Either hyposulphite of soda or cyanide of potassium may be

used as fixing agents. Intensification may be carried on after fixing if required. This, perhaps, is a safer plan than doing so before.

Col. Wortley has recently used an alkaline developer of greater strength than the foregoing. He takes:—

1.	Carbonate of ammonia	80 grains
	Water	1 ounce
2.	Bromide of potassium	12 grains
	Water	1 ounce
3.	Pyrogallic acid	96 grains
	Alcohol	1 ounce

To every four drachms of No. 1 he adds fifteen minims of No. 3 and twenty minims of No. 2. This developer is most powerful, and lessens exposure to a very great extent. With gum-gallic plates Mr. Gordon finds that the exposure should be the same as for wet plates when the developer is employed. It answers well for all plates excepting those prepared with albumen.

This strong alkaline developer is the greatest photographic discovery of the day. In using it, the plate should be edged with india-rubber,* and after washing, be levelled on a levelling stand. The developer should be poured on and allowed to remain undisturbed till all detail is apparent, when the negative may be intensified in the usual manner. If silver be used to intensify, an acid solution must be previously employed, to neutralize any free ammonia present.

COMMERCIAL DRY PLATES.

There are several firms which supply dry plates ready prepared. The Liverpool Dry Plate Company, of Seaforth Vale, Liverpool, supply collodio-bromide plates, as do the Uranium Dry Plate Company, of Grove End Road, London. The latter are of the formula worked out by Col. Wortley, with the addition of organic salt of silver in the emulsion. Messrs. Rouch and Co., of Norfolk Street, Strand, supply the Russell Rapid Dry Plates, which are likewise collodio-bromide. Collodio-albumen plates are also prepared by T. Pollitt and Co., Barlow's Court, Market Street, Manchester. With all of these full directions for exposure and development are sent out. The photographer will often find the purchase of any of these dry plates a boon, when too busy to prepare his own.

* The india-rubber prevents the developer flowing over the edges.

FIXING SOLUTIONS FOR WET AND DRY PLATES.

Fixing solutions for both wet and dry plates are here given:—

1.	Hyposulphite of soda	1 ounce
	Water	6 ounces
2.	Cyanide of potassium	25 grains
	Water	1 ounce

SILVER PRINTING.

Chloride of silver darkens when exposed to the action of sunlight. It assumes a deep violet tint, and, if it be immersed in water, traces of free chlorine will be found to have been liberated. The light then, by its vibratory force, decomposes the molecule of chloride of silver into a sub-chloride and chlorine gas. Chemically, it is expressed thus—

$$\overbrace{3Ag\,Cl}^{\text{Chloride of Silver.}} = \overbrace{Ag_3\,Cl}^{\text{Sub-chloride of Silver.}} + \overbrace{2Cl}^{\text{Chlorine.}}$$

Chloride of silver is formed by double decomposition similarly to the iodide (see page 2). It is soluble in hyposulphite of soda, cyanide of potassium, similarly to the iodide of silver, as shown at page 7, and also in ammonia. When chloride of silver has been acted upon by light, and the sub-chloride has been formed, the hyposulphite or other fixing agent re-converts the sub-chloride partially into chloride of silver, and partially into metallic silver. Thus—

$$\overbrace{Ag_3\,Cl}^{\text{Sub-chloride of Silver.}} = \overbrace{Ag\,Cl}^{\text{Chloride of Silver.}} + \overbrace{2Ag}^{\text{Silver.}}$$

The fixing agent dissolves the chloride of silver, leaving the metallic silver unaltered.

When nitrate of silver is brought in contact with an organic substance, the resulting compound is found to be affected by light in a somewhat peculiar way: the compound slowly darkens to a reddish tint; the exact chemical reaction that takes place is very complex to trace, but it may be accepted that an oxide of the organic matter and silver is formed. This oxide is stable, unlike the sub-oxide of silver, and is not acted on by fixing agents to any great extent.

It has been found that a certain proportion of the chloride in

combination with the organic compound aids the rapidity of change of colour of the latter. If a paper be coated with albumen (say) in which has been dissolved a certain quantity of a soluble chloride, and floated on a silver solution, both chloride and albuminate of silver are formed. It depends, however, on the strength of the solution as to what proportions of each are present, owing to the fact that the organic compound is much slower in formation than the chloride; if the silver solution be not sufficiently strong, the chloride may rob that portion of it, with which it is in contact, of all the silver before any (or, at all events, sufficient) albuminate has been formed, the molecule being composed almost entirely of chloride of silver. The stronger the silver solution the more "organate" will it contain; whilst if it be very weak, none at all may be present. Hence it is that with albumenized paper which is weakly salted with a soluble chloride a weak sensitizing bath may be used, whilst if it be rich in the chloride it must be of proportionate strength.

One other chemical reaction in printing must be considered, viz., that of the free nitrate of silver which is always present. During printing, as stated, the chloride of silver becomes reduced to a sub-chloride, evolving chlorine gas. This chlorine has a stronger affinity for silver than has the nitric acid (with which it is in combination in the nitrate of silver), and, consequently, it combines with the silver, forming new chloride of silver, which, in its turn, enters into a combination with the organate, liberating nitric acid.

This freshly-formed organo-chloride in its turn blackens by the action of light, and adds to the strength of the image formed. If the free nitrate of silver were absent, we should have the chlorine attacking the darkened organo-chloride of silver already formed,* and partially bleaching it. The result would be "measly" or mealy prints—*i.e.*, prints in which minute red spots alternate with darker ones in the shadows after fixing.

From the first part of this article it would be gathered that, as the sub-chloride of silver is much more acted upon by a fixing agent than the product of the organate *after* it has been considerably affected by light, the molecules formed of the organo-chloride of silver, when only partially acted upon by light, would be much more easily attacked by the fixing agents than when

* Thus, $Ag_3Cl + 2Cl = 3AgCl$, leaving the organate of silver coloured, whilst the subchloride of the molecule was bleached.

fully acted upon. This is the case: the blacker an image formed by the organo-chloride becomes, the less it is attacked by the fixing agent. As a consequence, the half-tones of a picture are attacked by it proportionately more than the shadows.

The most important of the organic substances used in printing is albumen. It has been used hitherto in preference to any other organic compound, on account of the delicate film it forms on the paper, free from all roughness, and also on account of the beautiful colour the print takes by the production of the albuminate of silver. The albumen should be used fresh, and in a slightly alkaline condition. The principal commercial objection to its employment in such a condition as the foundation of the picture arises from the difficulty that is experienced in coating the paper evenly with it. Makers of paper prefer old albumen, which gives a slightly acid re-action. When in this last condition, the paper is easily coated, though the toning is retarded, and inferior pictures are the result.

Gelatine is the next important organic substance to be remarked upon. The organate of silver formed with gelatine gives redder tones than the albuminate. In sizing it is frequently employed, and for pictures which it is intended should be of a reddish tone when printed, such paper may be used.

Starch imparts a more purple tint to the picture than the foregoing. Those papers sized with this substance yield the pictures, on toning, of a blue tint.

Tartarate of silver darkens to a deep purple colour, whilst the citrate turns a deep bright blue. Both of these tend to modify the tone of the print.

There are two kinds of paper principally used for albumenizing—Rive and Saxe. They both are starch-sized papers. The latter is much more porous, and consequently less glossy, than the former. Rive paper is, however, tender when wet, and tears easily when used in large pieces, such as required for large prints.

Saxe, therefore, is preferred for large prints, whilst the Rive is admirably adapted for *small* pictures where great gloss is requisite.

Saxe paper can be rendered nearly as glossy by doubly albumenizing and rolling. As this is a process only conducted by a manufacturer, its details are not given here.

The following is a useful formula for preparing albumenized paper on a small scale:—

Chloride of ammonium	... 100 to 200 grains
Spirits of wine	½ ounce
Water	4½ ounces

When these are thoroughly dissolved, 15 ounces of albumen* should be added. These ingredients then should be beaten up with a bundle of quills or a swizzle-stick. Constant shaking for half an hour in a bottle holding about double the quantity of mixture prepared will answer instead.

Having allowed the deposit in the albumen to settle, it is filtered through a sponge placed in a funnel, and from thence poured into a porcelain or other flat dish. The paper being cut into sheets of convenient size, the opposite corners of a sheet are then taken up by the manipulator (one in each hand), and a convex surface, the smooth side being underneath, is given to it by nearly bringing the two hands together. The middle of the paper first touches the albumen solution, and the corners held by the hands are gradually brought down till the sheet floats on the liquid. This method of procedure prevents the formation of air-bubbles on the surface of the paper, as they are squeezed out by the sheet in progress. The sheet should remain upon the solution a little over a minute, and should then be raised very gradually off by one corner, and hung up by two corners to dry. Two American clips answer for holding the paper whilst drying. Should bubbles be apparent, the paper must be floated again, till a uniform surface is secured.

When dried, the prepared paper should be rolled and put away flat.

Should the paper be floated much longer than stated above, the albumen, being prepared with an alkaline salt, is apt to dissolve the size and sink into the paper. This would destroy the gloss.

THE SENSITIZING BATH.

A good standard for a sensitizing bath is as follows:—

Nitrate of silver	50 grains
Distilled water	1 ounce

This solution is suitable for most albumenized paper of commerce that is in the market when it is required to print from

* The eggs used must be nearly fresh. Each good sized English egg will furnish one ounce, whilst an Indian one will only yield five-eighths of an ounce on an average.

good negatives of a fair density. The paper is floated on the sensitizing solution from about three minutes in hot weather to five in cold. The method of floating is similar to that given above for floating on the albumen solution.

Care should also be taken to withdraw the paper slowly, as the capillary attraction will remove nearly all excess of silver solution, and thus prevent a waste by the droppings, and a loss of time in drying. The paper should be hung up from one corner by an American clip, and a small piece of clean blotting-paper should be attached to the bottom corner to collect the excess of solution. This blotting-paper should afterwards be placed with the paper residues.

The sensitizing solution will generally be found to be below strength. This should be tested by the argentometer (which indicates the number of grains on its stem), or by the method given at page 42. The argentometer is somewhat uncertain, as it also indicates the amount of albumen and salts dissolved in the solution. It is, however, sufficiently correct for ordinary use.

The sensitizing solution, after a day or two, will be found to be discoloured. The discolouration is produced by the albuminate of silver, which gradually turns to a brown colour. The method of freeing the solution from it is given at the end of the book.

When the albumenized paper is very nearly dry, but not so much so as to crack on unrolling it when it is removed from the clip, it should be placed in clean blotting-paper between boards, in order to be flattened for printing. If the bath be new, and no injurious vapours (such as sulphuretted hydrogen) be in the air, it will keep from a couple of days in hot to a week in cold weather without discolouring.

Should a negative be found very hard, a slight modification of the sensitizing solution will be found beneficial, supposing the ordinary paper is to be used.

Nitrate of silver	30 grains
Water	1 ounce

The negative should in this case be printed in the sun. The more intense the light, the less contrast there will be in the print, the high-lights not offering such proportionate resistance to the passage of the actinic rays as is the case when diffused light is used. The reason for the reduction in quantity of the nitrate of silver in the solution is given on page 79.

To print from a weak negative, the sensitizing solution should be—

Nitrate of silver	80 grains
Water	1 ounce

The printing should take place in the shade; the weaker the negative, the more diffused the light should be.

If a negative be dense, but all the gradations of light and shade be perfect, the strong bath, and, if possible, a strongly-salted paper, should be used. The printing should take place in sun-light.

It may happen that with a very weak sensitizing solution the albumen may have a tendency to dissolve from off the paper; the addition of 10 to 20 grains of nitrate of soda, or a drachm of alcohol to the ounce, will prevent the evil recurring.

PRINTING THE PICTURE.

Skill is required for obtaining the most perfect prints from any negative, and it is only by paying attention to trifling details that such happy results can be obtained. It should be remembered that no blind adherence to any rules will attain the object in view; printing requires thought to be exercised, as well as clean manipulation.

In the foregoing article several hints as to the light that should be used for different qualities of negatives have been given, but the addition of extra manipulation may add to the beauty of the picture.

Should a picture print too black in the shadows—*i.e.*, attain a bronze colour—before the details in the lights have printed in, much improvement will be discerned by shading these dark portions. This shading may be done either by placing temporarily a paper, or gumming tissue paper, cut to the proper shape, on the front of the negative whilst printing. On the deepest shadows two or more layers of tissue paper may be gummed, till the desired effect has been attained. In some cases cotton-wool may be placed over a defective spot which prints in too quickly; and, in extreme cases, where high lights are wanted, a skilful touch of the brush (using Indian ink or sepia) will give a piquancy to the print which would not be otherwise obtained.

The sky in some negatives prints in too deeply; a mask, cut to the outline of the landscape, and slightly raised from the surface of the negative, will give a graduated sky, which, if left

too white, may be subsequently improved by "sunning" down. This sunning down is generally carried out by means of a sheet of non-actinic paper or cardboard. This is moved gently over the picture, leaving the upper portion of sky more exposed to the action of the light than the lower portion, the landscape itself being always completely covered up.

In many landscapes some secondary object, by the brilliancy of its high lights, may attract the eye. As the object of all artistic photography is to cause the eye primarily to dwell on the most important point, these bright spots, if they interfere with the effect of the picture, should be sunned down by shading all the print except that particular part. This may be done by using a brown paper mask, cutting out the shape of the object to be toned down. In this case the negative should be removed, and a clean piece of glass substituted for it in the printing-frame.

Transparent spots in the negative may be touched out on the negative itself. Gum should not be mixed with the paint used, for reasons given at page 38. Opaque spots in the negative print white in the print, and these can only be touched out on the print after it is fixed and dried.

In toning operations the print loses depth, varying in a great measure according to the toning bath used. This loss of depth should be allowed for in the printing, the picture when taken out of the frame being considerably darker than it should be when finished. To tell the depth of colour to be given is, perhaps, one of the most difficult things in photography to judge. Practice alone can determine when a print should be withdrawn from the frame.

After the negative has been placed with the film side towards the back of the frame, a piece of paper of the size of the plate should be placed on it. A felt or flannel pad should next cover the paper, and the back be placed over this.

The pad is principally used to cause an equal pressure being exerted between the negative and the paper. Should the pressure be unequal, the paper will be found not to be in contact at places, and there will be a fuzzy appearance at those parts of the print. Even when pads are used, it is not unfrequently the case that this want of contact exists. If the paper have been dried in a moister, hotter, dryer, or cooler atmosphere than that in which the printing takes place, this defect may ensue. In such cases it is a good plan to let the paper remain in the printing room half an hour before the printing commences, and to

place the sheet of paper on the negative in the frame, with the pad behind it, not pressing down the springs on to the back. The negative, of course, should be face downwards on the floor, to prevent the passage of light through it. After five minutes or so the paper will become contracted or expanded sufficiently to enable complete contact to be maintained.

A great source of defective prints is their examination during printing. The frame should never be opened in bright light, otherwise the whole exposed surface of the print may become discoloured, and the purity of the whites lost.

When prints are removed from the frames, they should be stored in a dark box, or between leaves of red blotting-paper in a large book.

TONING.

The object of toning a print is to change the reduced silver salt to a sightly colour after it has been immersed in the fixing bath.

The action of toning may be considered somewhat analogous to that of intensifying the negative, by change of colour; the reduction of metallic gold, from the chlorine on certain portions of the print, being similar to that of the metallic silver from the nitrate. The position of the portions of the picture on to which it is thrown down is determined by the position of the reduced silver on the paper. Where there is metallic silver, there the metallic gold is thrown down. The process might be almost called "electro-gilding." The ter-chloride ($Au Cl_3$) of gold, or a double salt of the ter-chloride of gold and potassium or sodium, is invariably used for the toning bath, as it is necessary that the electro-gilding action should take place with a salt of gold *in solution*. It is also found advantageous that the solution should be neutral—*i.e.*, neither acid nor alkaline—the reduction taking place more rapidly than with an acid solution. The deposition of gold is further aided by the addition of an acetate or carbonate of an alkali, &c., to form oxy-chloride of gold. When the ter-chloride of gold alone is reduced, chlorine is liberated, which attacks the silver in the print, forming fresh chloride of silver. That this action does occur may be shown by the diminished depth of colour the prints assume in the toning bath. The formation of an oxy-chloride of gold in the solution, however, somewhat reduces this change, a larger

deposit of gold being thrown down in a shorter time than if the addition of the carbonate, &c., had been omitted.

The following toning baths are found to give good results by different photographers. No. 1 is found to be very stable, and to give brilliant tones:—

No. 1.	Ter-chloride of gold	2 grains
	Chlorinetted lime (chloride of lime)...	2 ,,
	Chalk...	1 teaspoonful
	Water	16 ounces

If the water be hot, the bath may be used when cool; if not, a day should elapse between mixing and using it.

No. 2.	Acetate of soda	30 grains
	Ter-chloride of gold	1 grain
	Water	10 ounces

To be mixed the day before it is used.

No. 3.	Chloride of lime	45 grains
	Ter-chloride of gold	45 ,,
	Chalk...	45 ,,
	Acetate of soda	180 ,,
	Water	15 ounces

(These to be mixed together, without filtering, from seven to fourteen days before use. When required to use, filter out one ounce of solution, and add to eleven ounces of water.)

No. 4.	Ter-chloride of gold	1 grain
	Bicarbonate of soda	10 grains
	Water	1 ounce

May be used immediately.

Other toning baths have been employed, but the foregoing are the principal used with albumenized paper.

Nos. 1, 2, and 3 will keep indefinitely. When the bath becomes inactive from lack of gold, it may be strengthened by a solution containing only one ounce of water to the above quantities of the other ingredients. No. 4 can only be used on the day it is made.

According to the minuteness of the grains of gold, so will it assume, by reflected light, colours varying from purple to that of the ordinary yellow. The organo-chloride of silver appears through this layer of gold, and the colours of the two mingling together give the different tones in ordinary prints. When a

print is over-toned it becomes blue. This is due to the greater amount of gold deposited over the surface of the silver. The change in colour on the immersion of a print in the fixing bath is due to the solubility of the chloride of silver.

With all the toning baths, excepting No. 3, a little of the free nitrate of silver should be allowed to remain in the print—that is, before being immersed in the toning bath, the prints should not be too thoroughly washed (chemical reasons can be urged for this practice); whilst with the acetate bath it can be shown that all the soluble silver salt should be got rid of. In the first case, the prints should be washed in two changes of water, and the last change should show *decided* milkiness.* The paper is immersed in the water, albumenized face downwards, to prevent the chloride or carbonate of silver (that may be formed from the chlorides or carbonates in the water with the free nitrate of silver) being precipitated on the surface of the print, and the gold being deposited on it. Should there be a deposit on the print, it is dissolved away by the fixing bath, and leaves minute spots untoned.

The toning bath should be sufficiently large to contain a couple of the largest prints side by side. No more should be immersed in it than can be conveniently turned over without risk; eight or nine medium-sized prints are generally found sufficient. The bath should be given a continuous and gentle rocking motion, allowing the solution to flow over and between all the prints immersed. This prevents any two prints sticking together, and the consequent want of tone on those parts which have been in contact. The print must be toned a little further than it is intended to remain; for black tones a slight blueness must be perceptible. In all cases, however, it should possess a rich colour before fixing. It is a good plan to let the print tone face downwards, all deposit of chloride of silver, formed by the free nitrate of silver and the chlorine liberated from the terchloride of gold, being by this means kept from their faces.

FIXING.

Hyposulphite of soda is almost invariably used for fixing. A strong fixing bath is recommended, on the grounds that a double

* The milkiness is only perceptible when the water contains chlorides or carbonates.

hyposulphite of soda and silver is formed, and that this double salt is soluble in hyposulphite of soda. Consequently, if enough hyposulphite of soda be added only to form the double salt in the paper, the fixing is imperfect; whilst an excess of hyposulphite will dissolve it out of the paper, and leave the print amenable to washing. On these grounds the strength of the fixing bath has been made as follows:—

Hyposulphite of soda...	4 ounces*
Water...	1 pint

Between toning and fixing it is well to wash the prints slightly. After taking them out of the toning bath they should be placed in a dish of water, face downwards, till a bath is ready for fixing.

It will be noticed that the toning action on the print continues during this washing, presumably by the solution of gold contained in the pores of the paper continuing to deposit. The addition of a small quantity of common salt has been found useful to stop this action. If this precaution be not taken the prints first toned should be left redder than it is intended they should remain.

The prints should be immersed in the fixing bath for twelve or fifteen minutes.† The solution should be kept in motion during the whole time of fixing, as for toning. Care should be taken to brush off all bubbles that may cling to their surfaces, as the cushion of air impedes the access of the liquid to the silver salt.

When the prints are fixed they will appear colourless in the whites, and free from red patches in the dark portions.

In some establishments it has been found advantageous to add a drachm of ammonia to each pint of fixing solution. The ammonia aids the rapidity of fixing; it also attacks the size of the paper, dissolving it out from the paper in a great measure. This renders the washing more perfect, and is found to prevent "blistering," which is common with so many albumenized papers.

The prints should be withdrawn slowly from the bath—in

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* One ounce of hyposulphite of soda will fix *with safety three sheets of paper.*

† The thicker the paper the longer the time of immersion.

order that all excess of the hyposulphite solution may be drawn from them by capillary attraction—and placed in a trough of water, where they should soak a quarter of an hour. They should then be removed, as before, and placed in a stream of running water for twelve hours. If running water be not attainable, a good plan is to place the prints in a dish, changing the water every half hour for five or six changes, and sponging all the moisture out as far as possible after every second change. By this procedure the hyposulphite is almost totally eliminated. Prints washed in this manner have remained unaltered in colour for the last ten years in the writer's experience, having passed through both dry and moist climates, varying in temperature from 20° to 110°.

It is useful sometimes to test the water for hyposulphite of soda after the last washing, in order to ascertain if its extraction be complete. The following is a most delicate test.

Make the following test solution:—

Permanganate of potash	2 grains
Carbonate of potash	20 ,,
Water	1 quart

The addition of a few drops of this rose-coloured solution to a pint of water will yield a slightly pink tinge. If there be any trace of hyposulphite of soda present, the colour will be of a greenish hue.

If permanganate of potash be not at hand, the following well-known iodide of starch test may be adopted:—

Take about two drachms of water and a small piece of starch about the size of a small pea, powder and boil the starch in the water till the solution is quite clear; add one drop of a saturated solution of iodine in alcohol to this clear liquid. It will now become dark blue. Of this solution drop two drops into two clean test tubes, and fill up one with distilled water; fill up the other with the water to be tested; a faint blue colour should be perceptible in the first test tube. In the second test tube, should hyposulphite be present, this blue colour will have disappeared, the iodide of starch becoming colourless in its presence. The best mode of comparing the two waters is by placing a piece of white paper behind the test tubes.

It frequently occurs that though hyposulphite of soda cannot be detected in the washing water, it may be present in the paper itself. The paper on which most prints are taken being sized

with starch, if a *very* weak solution of iodine be applied with a brush across the *back* of a print a blue mark will indicate the *absence* of the hyposulphite. Care must be taken that the iodine solution is *very* weak, otherwise a part of the iodine will first destroy the trace of the salt, and then the remainder will bring out the blue re-action.

The dishes used for *toning, sensitizing, and fixing should be used for no other purpose* than that to which they are originally allotted. A porcelain dish on which the glass has cracked should be rejected for the sensitizing dish and for the fixing dish. In the first case the porous porcelain absorbs a vast quantity of nitrate of silver; and in the latter old hyposulphite of soda, where it is *very* apt to cause yellow markings on the prints.

Tin dishes should be avoided in all cases. The tin corrodes and marks the pictures. Perforated zinc is often used for the bottoms of washing troughs. It should be avoided, as after a time it becomes fouled, and marks the prints when they rest on it.

WASHED SENSITIVE PAPER.

A method of keeping albumenized paper sensitive for long periods (say for a week or a fortnight) without discolouring has been lately introduced. It is said to be more sensitive, to tone more rapidly, and to give more uniform results than the ordinary sensitized paper.

The paper, sensitized as usual, is passed, face downwards, through two or three changes of water* (not soaked), and hung up to dry. The pads of the pressure frame must be fumed with ammonia previous to using the washed paper, in order to produce a rich print. Colonel Stuart Wortley's plan seems the best method of impregnating them with ammonia. He places all the pads to be used in a large box overnight with a little strong ammonia in a saucer at the bottom of the box; by the morning they are sufficiently fumed.

The sensitizing bath should not be acid. If a small quantity of carbonate of silver† remain at the bottom of the bottle holding the stock solution the acidity is prevented. A small quantity of powdered chalk added to the bottle answers equally well.

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* All the free nitrate of silver must not be washed away, otherwise the print will want in depth of tone.

† The addition of carbonate of soda will form the carbonate of silver.

Colonel Stuart Wortley uses the following bath for sensitizing paper that is to be washed :—

Nitrate of silver	35 grains
Nitrate of lead	13 ,,
Sugar	2 ,,
Water	1 ounce

The washed paper may be stored between clean and dry blotting paper, and pressed between two flat boards. The less air admitted to it the longer it will keep.

DURABLE SENSITIZED PAPERS.

In the market there are two or three permanent sensitized papers, Durand's and Henderson's being the best known. They are printed, toned, and fixed in the usual manner. There is sometimes a slight lack of vigour in the resulting prints, however, which is partially overcome by fuming the pads as described above.

Mr. Hopkins has adopted a method of preserving sensitive paper. He floats the sheets of albumenized paper on a 40-grain bath, as usual; then dries till nearly all the moisture is gone. He then places them between sheets of blotting-paper previously impregnated with carbonate of soda solution (about thirty grains to the ounce of water) and allowed to dry. The pile of paper he places under pressure, and uses as required.

Another plan of keeping paper in a sensitive condition is by adding from twenty to forty grains of citric acid to each ounce of nitrate of silver solution. Many find this to give good results, whilst others find a lack of vigour after toning.

PLAIN SALTED PAPER.

Prints on plain paper are useful in certain instances. The formula for preparation is given :—

Chloride of ammonium	60 to 80 grains
Citrate of soda	100 ,,
Chloride of sodium	20 to 30 ,,
Gelatine	10 ,,
Distilled water	10 ounces
Or,	
Chloride of ammonium	100 grains
Gelatine	10 ,,
Water	10 ounces

The gelatine is first dissolved in hot water, and the remaining components of the formulæ are added. It is then filtered, and the paper is floated for three minutes, as given in Albumenizing Paper. If it be required to print on plain paper in a hurry, a wash of citric acid and water (one grain to the ounce) may be brushed over the back of ordinary albumenized paper, and, when dried, the back of the paper may be sensitized and printed in the ordinary manner. For cold tones the wash of the citric acid may be omitted.

PRINTING WITH COLLODIO-CHLORIDE.

The collodio-chloride process was introduced by Mr. G. Wharton Simpson, the editor of the PHOTOGRAPHIC NEWS. It is useful for a variety of purposes, some of which will be found in subsequent articles. Primarily, it was introduced for printing on glass or paper, and for such it is given here.

The collodio-chloride is formed as follows:—

*No. 1	Nitrate of silver	1 drachm
	Distilled water	1 ,,
No. 2	Chloride of strontium	64 grains
	Alcohol	2 ounces
No. 3	Citric acid	64 grains
	Alcohol	2 ounces

To every two ounces of plain collodion add thirty drops of No. 1, previously mixed with one drachm of alcohol; then add one drachm of No. 2, shaking well at the same time; lastly, half a drachm of No. 3 solution. In a quarter of an hour it is fit for use.

The paper best adapted for the reception of the collodio-chloride is arrowroot paper. A paper rather larger than the size of print required is taken, the edges turned up for one-eighth of an inch all round to form a tray, leaving a small spout at one corner. This paper is then pinned on to a board by the four corners, and is coated in a dark-room with the collodion as for the collodio-bromide process. When well dried, it may be found to increase the brilliancy of the resulting print by pinning it on the inside of the lid of a large box, and exposing it to the fumes of a drachm of ammonia poured into a saucer.

The print is taken in the ordinary manner, and may be toned

* The formulæ are taken from the YEAR-BOOK OF PHOTOGRAPHY for 1871.

by any of the ordinary toning baths, the lime bath (No. 1, page 86) being the best, providing it be old.

The following toning bath made in two separate solutions gives rather inky tones :—

No. 1	Sulphocyanide of ammonium ...	1¼ ounces
	Hyposulphite of soda	45 grains
	Bicarbonate of soda	15 „
	Water	50 ounces
No. 2	Chloride of gold	30 grains
	Chalk	1 teaspoonful
	Water	50 ounces

Equal quantities of these are taken and mixed, and the toning proceeds as usual. The prints ordinarily take from two to ten minutes to tone. If a longer time be required, add more gold till the desired effect is produced. This toning bath can only be used once.

FIXING BATH.

The fixing bath is composed as follows :—

Hyposulphate of soda	1 ounce
Water	30 ounces.

The print should be immersed in this about eight minutes.

DEFECTS IN PRINTS.

Small white spots, with a black, central pin-point, are often met with in prints. Dust on the paper during sensitizing will cause them, the grit forming a nucleus for a minute bubble. All paper should be thoroughly dusted before being floated on the sensitizing bath.

Grey, star-like spots arise from small particles of inorganic matter, such as oxide of iron, lime, &c., which are present in the paper. They become more apparent by decomposition during the printing operations. They may generally be discernible by examining the paper by transmitted light.

Bronzed lines (straight) occur through a stoppage during floating the paper in the sensitizing solution. Should the lines be irregular, forming angles and curves, it is probable that a scum of oxide of silver, &c., may be detected on the surface of the sensitizing solution. A strip of blotting-paper drawn across the bath will remove the cause of the defect.

Should the print appear marbled, it may be surmised that the

sensitizing solution is weak, or that the paper has not been floated long enough. In some cases it may arise from imperfect albumenizing; but, in ordinary commercial samples, the cause can be easily traced.

Red marks on the shadows may appear during toning, and are very conspicuous after fixing. They generally arise from handling the paper with hot, moist fingers, after sensitizing; grease being deposited on the surface, prevents the toning bath acting properly on such parts.

Weak prints are generally caused by weak negatives. Such can be partially remedied by paying attention to the strength of the sensitizing bath (as shown in page 82), and by using washed paper.

Harsh prints are due to harsh negatives. They can generally be remedied by paying attention to the mode of printing, also given at page 83. If the negative be under-exposed and wanting in detail, there is, however, no cure for this defect.

A red tone is due to insufficient toning; whilst a poor and blue tone is due to an excess of toning.

The whites may appear yellow from imperfect washing, imperfect toning, or imperfect fixing.

Should prints refuse to tone, either the gold has been exhausted, or else a trace of hyposulphite of soda has been carried into the toning bath by the fingers or other means. A trace of hyposulphite is much more injurious to the print than a fair quantity of it. Should the toning bath refuse to tone after the addition of gold, it may be presumed that the toning bath is contaminated by a trace of hyposulphite of soda. In this case add an ounce of hyposulphite to a pint of solution, and the toning action will probably be set up.

A dark, mottled appearance in the body of the paper indicates imperfect fixing, combined with the action of the light on the unaltered chloride during fixing. If the fixing bath be acid, the excess of acid combines with the sulphur, and forms hydrosulphic acid, which will also cause the defect.

The cause of mealiness or "measles" in the print has been explained in pages 79 and 87.

Maxims for Printing.

1. The print should have the highest lights *nearly* white, and the shadows verging on a bronzed colour before toning.
2. Place the prints, before toning, in the water, face down-

wards, and do not wash away too much of the free nitrate of silver (see exception, page 86).

3. The toning solution must be neutral, or slightly alkaline, and not colder than 60°.

4. Tone the prints to purple or sepia, according as warm or brown prints are required.

5. Move the prints, in both the toning and fixing solutions, repeatedly, taking care that no air-bubbles form on the surface.

6. Take care that the fixing bath is not acid.

7. Use fresh hyposulphite of soda solution for each batch of prints to be toned.

8. Wash thoroughly after and before fixing.

9. Make a sensitizing bath of a strength likely to give the best results with the negatives to be printed.

10. Print in the shade, or direct sunshine, according to the density of the negative.

PERMANENT PIGMENT PRINTING.

If gelatine be mixed with a solution of chromic acid, and dried in non-actinic light, it will be found that it is perfectly soluble in water. If, however, it be exposed to the action of light, it will be found to have become insoluble. On this rests the whole superstructure of permanent pigment printing, photo-lithography, heliotypy, papyrotypy, and such processes akin to them.

The chemistry of the process is rather involved in difficulties, on account of the organic changes that may take place in the gelatine. It will suffice to point out the main action that takes place, viz.:*—"That gelatine, aided by light, reduces the chromic acid of the bichromate (KO_1, CrO_3) to a lower state of oxidation, and then enters into combination with a compound of chromic oxide (Cr O), produced by the mutual decomposition of the chromic acid and gelatine, the original being the formation of a leather-like substance,"* insoluble in hot water. The addition of various substances to the gelatinous compound have been found to aid this decomposition.

The first process that is to be described is known as the "Autotype."

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* From a paper read before the Photographic Society, May 10, 1870, by Mr. Swan.

Messrs. Spencer, Sawyer, and Bird have secured the Autotype Company's patent, and issue pigmented sheets or bands of paper. The pigment consists of gelatine, sugar, soap, and colours of every tint. These are the foundation of all their permanent prints.

The tissue can be supplied ready sensitized, and be transmitted by post; otherwise it is necessary to float it on a solution of bichromate of potash and water—

Pure bichromate of potash ...	1 ounce
Water	20 ounces.

The bichromate of potash should be nearly neutral, and contain no free acid. Should it contain acid, the tissue is liable to become insoluble. Free acid* may be neutralized by the addition of potash in solution (KO,HO) till no extraordinary acid reaction is evident to blue litmus paper. A dish somewhat larger than the paper to be floated is used for floating. The solution should be at least a quarter of an inch in depth in the dish. The piece of pigmented paper is taken, and a quarter of an inch folded back at one end at right angles, and rolled up to a diameter of about two to three inches, gelatine surface outside. The turned-up end remains on the outside of the roll. The angle of the folded end is now dropped upon the solution, and the coil of paper is allowed to unfold itself, driving out all bubbles behind as its surface comes in contact with the solution.

The floating should last from two minutes in warm weather to three in cold.† The turned-up end should then be pinned by a couple of pins on a thin lath, and slowly withdrawn from the back, and hung up to dry.

The drying of the tissue should take place in a room perfectly free from vapours, such as sulphuretted hydrogen, or those produced by the combustion of gas. If possible, a current of warm, dry air should be created through the drying room; in summer, a large candle placed in a chimney will create sufficient draught, if the paper be dried near the fireplace. The quicker the paper dries the better will it work, though the less sensitive it is to light.

When quite dry, the paper is exposed under the negative in the ordinary manner, a "safe edge," as it is technically termed, being placed round it. The safe edge consists of a mask of brown

* Bichromate of potash always shows a slightly acid reaction to test-paper.

† Should the temperature of the solution exceed 80° F., it must be reduced by adding a little pounded ice.

or other non-actinic paper, externally larger than the negative, and internally slightly smaller, the negative being, as it were, framed by it. The pigmented paper must be slightly larger (say half an inch each way) than the size of the print required. If the print be examined during exposure it will be seen that, owing to the colours added, there is no change in its appearance, consequently it is necessary to use an actinometer to time the exposure.

The autotype actinometer consists of a slip of albumenized paper,* rendered sensitive by a standard silver solution. This becomes tinted or coloured by exposure to the light. The tint thus produced is compared with a standard one, *painted* on a strip of paper or tin. When about to be used, a small portion of the strip of paper is exposed to the light simultaneously with the print. When the paper has attained the colour of the painted paper or tin, it is said to have had one tint. A fresh piece of paper is then exposed for another tint, and so on.

For a negative of ordinary density two tints will generally be found sufficient in summer, and probably five in winter, but judgment must decide the time required for different negatives.† The tissue is then withdrawn from the frame in a room in which the light is weak or non-actinic. Close at hand, on a table, should be a dish containing water to a depth of an inch or more. To the bottom of this is sunk a finely-mulled flat zinc plate, at least one inch larger each way than the negative; the paper is now drawn, face downwards, under the water, till it nearly rests upon the zinc plate. It will be noticed that paper at first tends to coil downwards, but gradually unrolls till it is perfectly flat, and if left it would coil upwards. At the moment it has become flat, the zinc plate is seized by the hands, and raised horizontally out from the dish, the tissue resting upon it. It is then placed on a small low stool standing in another dish; one end of the paper is next pressed on to the zinc plate by one hand, and with the other the remaining portions are brought into contact with the "squeegee."‡ The

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* The Autotype Company used Carrier's paper for a long time. Durand's and Henderson's permanently sensitized paper answer equally well.

† The method of under-printing and allowing the action to continue in the dark, or non-actinic light, is given in the Mariotype Process, and applies to this.

‡ The squeegee consists of a flat piece of wood about two inches wide, and three-sixteenths thick, into one edge of which is let a strip of india-rubber about

first portion of the tissue is then brought into contact with the zinc in the same manner.

The zinc plates used are termed the "temporary supports" of the tissue. They are mulled in the ordinary manner with a muller and fine sand; the finer the grain given, the finer in detail will be the resulting pictures. Care should be taken that no scratches are on them, as every scratch is reproduced in the finished print. It was found by Mr. Johnson, who introduced this method of transferring the prints, that it was necessary to coat the plates with a fatty and resinous substance, of sufficient tenacity to keep the prints on them during development, but which should have less adherence to them than the film of gelatine has to the paper with which it is to be backed or mounted.

The following is the composition of the fatty body:—

Beeswax	3 drachms
Yellow resin*	3 ,,
Oil of turpentine	1 pint

These proportions are not absolute, as the composition of the beeswax varies. The resin must be added to the beeswax in such proportions that the gelatine film will remain on the plate without cracking or peeling, even when dried in a hot room, but at the same time will leave the plate readily (when the applied transfer paper has become dried) without the application of any force.

Take a piece of fine flannel, or cotton wool, and with it rub a small quantity of the above fatty body on to the plate. With another piece polish off the excess of grease, leaving but a *minute* layer of the compound. The zinc plate is then ready for the transference to it of the tissue.

The zinc plates are cleaned, after being used, by rubbing with flannel in boiling water. If this be not sufficient, a little turpentine or ammonia will cleanse them thoroughly, and render them fit for a fresh application of the fatty compound.

Development is best effected by a trough or tin basin containing water, whose temperature can be maintained at 100° F. by aid of

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half-an-inch wide, and projecting half that distance; the length of both the lath and india-rubber vary according to the size of the zinc plate. It is used by pressing the india-rubber edge against the paper, and passing it hastily over the surface.

* The resin causes the adherence of the film to the plate, whilst the beeswax diminishes that adherence to the limits above stated.

a gas jet or a spirit lamp. After the pigmented paper has been pressed into contact by the squeegee with the zinc plate, it should be laid aside for a couple of minutes to allow the gelatine to swell. By the swelling of the gelatine, a partial vacuum is created between it and the zinc plate, and the pressure of the air outside prevents it from peeling or stripping off. The zinc plate, with the adhering paper, is next placed horizontally in the trough for a minute, when it will be found that the paper can be peeled off, leaving the gelatine pigment on the zinc plate. The plate is now moved vertically in the water; and gradually those parts of the gelatine which have been unacted upon by light will dissolve away, leaving the picture beautifully developed, with its half tones and deep shadows in perfect gradation. When the water flows from off the plate quite free of colouring matter it should be withdrawn, and then placed for a few seconds in alum and water (a dessert spoonful to a couple of gallons will suffice). This renders the remaining gelatine perfectly insoluble. Should a picture be only slightly under-exposed, plunging the plate into the alum water, at the stage required, will stop development and give a passable print. If a picture be slightly over-exposed, water heated to 130° will often reduce its depth sufficiently. The plate, with the picture on it, should lastly be well washed under the tap to rid it of any traces of alum, and then set up in a rack to dry.

It may seem curious to some that the pigmented gelatine should have to be transferred from paper to zinc plates to be developed, or, in other words, that development takes place from the back of the gelatine. A little thought will clear up the mystery. The light acts on the pigment according to the actinism and *time* of exposure. A ray of light will penetrate in two seconds to twice the depth it will in one, and consequently, in one second only half the thickness of gelatine is rendered insoluble in water, in comparison with that rendered insoluble in two. Reasoning further, it will be evident that the part rendered insoluble is at the surface, and that which remains soluble is nearest the paper. Again, if only half the intensity of light act on one portion, whilst another has the whole acting on it, only one half the thickness of the layer will be rendered insoluble in the first case, in comparison to that so rendered by the second. It is this condition of light that acts on the film through an ordinary negative, the gradations of density permitting different intensities of light to pass on

to the pigmented paper. Now, supposing it were attempted to develop the picture on the paper itself; it would be found that *nearly* all the *surface* of the pigment had become insoluble, and that, consequently, this leather-like substance would prevent the dissolution of the underneath portions, which were still soluble.

The best exposure for the paper is evidently when the light has penetrated in the deepest shadows just to the surface of the paper, whilst the densest parts of the negative have not allowed the passage of *any light*. It will be seen from this that a negative should possess similar good qualities as for silver printing.

The print on the zinc plate will be found to be reversed. This is right, as in the re-transfer it will be found to be in its proper position. The transfer paper is coated with a preparation of insoluble gelatine. The re-transfer on to paper is effected in a similar manner to the transfer of the pigmented paper to the zinc. The paper is plunged into water of a temperature of about 170°, where it remains till it becomes slimy to the touch. The plate bearing the dried picture is now dipped into cold water, and carries as much as possible away with it in a horizontal position on to the stool already mentioned. The transfer paper is then placed, prepared side downwards, upon the cushion of water, and is "squeegeed" into close contact with the picture as before. It is then allowed to dry spontaneously (in the sun if possible), after which it will be found readily to leave the plate, bearing with it the picture on its surface. If dried by the sun it will coil off the plate of its own accord. If the paper be too hastily dried by the fire it will buckle and become cockled, and can only be flattened with difficulty.

If a matt surface be required, the print may be finished by rubbing with cotton-wool holding a little turpentine. A brilliant surface can be given by using an encaustic paste as for silver prints:—

White wax	1 ounce
Benzole	1 ounce

dissolved by the aid of heat;

Or—

White wax	1 ounce
Oil of turpentine	1 ounce

dissolved also by the aid of heat.

For printing portraits a glass plate may be used in lieu of the

zinc. The surface should be rubbed over with the waxing compound. Great care is requisite that the resulting surface is free from lines, as it should be remembered that every line on the surface of the plate will be exactly reproduced in the print. The glass may also be coated with a film of plain collodion (which should be *perfectly* transparent when dry), and after varnishing round the edges the film may be used for the transfer. When re-transferred on to paper the collodion is detached, and the surface of the print is brilliantly glazed. It is advisable sometimes to rub the plate once, before applying the collodion, with a little white wax dissolved in ether. This facilitates the film leaving it. Mr. Johnson likewise coats the glass plate with water varnish, prepared as given for heliotypy.

Mr. Baden Pritchard re-transfers the picture *before* it has dried in the ordinary manner. He dries it after re-transferring by placing the zinc plate on a wide ring over a gas-burner. His observations led him to think that there is no deterioration in the print from this method. The danger to be apprehended is a separation of the film at the junction of the high lights with the shadows.

In practice (owing to indifferent gelatine being employed, or through other circumstances) occasional prints with cracks in the film, having an appearance of crape, are met with. These may often be remedied by placing the finished print in water of about 130° F., and leaving the gelatine to swell up once more. When dried, it will be found that the cracks have disappeared.

SINGLE TRANSFER PRINTS.

There is another method of producing carbon prints without transferring them to zinc, viz., by transferring them direct to the paper on which they should finally rest. In order to employ this method it is necessary to obtain a reversed negative. The transfer paper, prepared as for the autotype process, is soaked in very hot water (see page 101), and, after the carbon tissue has been passed through cold water, the two surfaces are brought together by the squeegee or by pressure. The two papers are then immersed in warm water of about 100°, and the backing to the pigmented paper stripped off. The development of the positive takes place as usual, and the paper bearing the print is hung up to dry, when it is ready for mounting and finishing.

Single transfer gives more delicate results than the double,

no grain of the zinc being present to mar the half-tones. Vignette portraits may be printed by it, which is not the case by double transfer. The drawback to the process is the necessity of having a reversed negative.

MARIOTYPE.

Some two years ago it came to the writer's notice that the length of exposure to actinic light necessary to produce a print by the autotype carbon process might be diminished by three-quarters, or even seven-eighths, by withdrawing the print from beneath the negative, and leaving it in the dark. The printing action started continued gradually, and finally, after a lapse of several hours, on development, the picture was found to be fully printed. In winter this curious continuating printing action was of special value, as it enabled eight times the number of prints to be produced from a negative by giving only an eighth of the right exposure, and then keeping them in a dark room. The writer also experimented with certain non-actinic lights, and found the same action was maintained, but with greater rapidity. Hence hanging a partially exposed print up in a yellow lighted room was better than leaving it in the dark. M. Marion, of Paris, has taken advantage of this fact, without acknowledgment, and on it is founded Mariotype. The following is his account, extracted from the PHOTOGRAPHIC NEWS, May 23rd, 1873:—

"I have the honour to submit to the attention of the Photographic Society of London two novel and original methods of producing pigment prints. They are of a most practicable nature, and may be defined as partaking of the qualities of the well-known carbon method and the collographic process; I have termed them 'Mariotype by pressure,' and 'Mariotype by contact.'

"For Mariotype by pressure a simple vertical press is necessary, such as is employed for collographic or Woodbury printing. Only one single exposure under a negative is required, the image or printing block thus obtained serving to transmit the sensitive action to the pigment paper which gives rise to the picture and transfers it to the paper support.

"A Mariotype sheet (D) of gelatine, of a matt white colour, is sensitized on a four per cent. solution of bichromate of potash, dried, and exposed under a negative for a suitable period, the

image produced being a visible one. This sheet is next put into another bichromate bath, half the strength of the former one, the result being the same as if it were dipped into cold water. Those portions of the gelatine sheet which have not been acted upon by light swell up, while the solarized parts remain as hollows upon the surface, according to the degree to which the same has been acted upon.

"The gelatine sheet is taken from the bath, freed from an excess of moisture, and is now put into the press ready for printing from. Instead of applying ink to the block, as in the collographic process, an alum-bichromate solution is made, composed of:—

Water	... 100 parts
Chrome-alum	... 2 ,,
Bichromate of potash ...	... 2 ,,

This is applied with a sponge, and the excess removed with blotting-paper. A piece of pigment tissue is then put under the press, upon the printing block, impregnated as it is with alum bichromate solution, and the two surfaces screwed together.

Afterwards the pigment tissue is withdrawn from the press, and another piece substituted, the printing-block being first moistened again with a sponge full of alum bichromate solution, and the excess removed by blotting-paper. In this way an unlimited number of copies may be produced, the pigment tissue becoming impressed, or solarized, so to speak, in those parts corresponding to the design with which it has been placed in contact. All the operations must be carried on in a locality sheltered from glaring daylight; but when the invisible images upon the pigment tissue have been produced, they are placed for a few minutes where the light can act upon them. They are then ready for application to their support, coagulated albumenized paper.

"The printed pigment tissue is plunged into cold water together with the albumenized paper, and then withdrawn in contact, placed upon a glass, and rubbed with a squeegee. The development of the image is next undertaken by the aid of warm water of a temperature of 40° to 50° Centigrade. The half-tones are admirably preserved, and the print, contrary to what happens in collographic printing, is produced in its true aspect, because, of course, the transmission of the image goes from one surface to the other, or, in other words, an impression

and counter-impression are produced. In the daytime a large number of prints may be thus produced by pressure, exposed to daylight for the few minutes required, and the rest of the operations may then be pursued during the evening at leisure. In about an hour as many as fifty carbon prints may be obtained, equal and uniform in their nature—and this, too, by simply one exposure to light to obtain an image to serve as a printing-block, the pressure of a piece of pigment tissue in contact being sufficient to produce copies therefrom.

"'Mariotype by contact' is different in its nature. It is well known that in the ordinary carbon process at least two descriptions of paper are employed—pigmented tissue and transfer paper. A third is sometimes used for an intermediate transfer, or as a provisional support to the image.

"In producing pictures by Mariotype by contact, no transfer of the image is necessary, and yet the print is obtained in its true aspect. Instead of sensitizing or exposing the pigment tissue, I sensitize and expose the transfer-paper. The image is then produced in its proper aspect, just the same as in silver printing, but the image is of a pale brown tint, and without vigour. The paper which I employ for transferring is of a very slightly gelatined nature (C)—although I think it would be better to have it albumenized, waxed, and gelatined—and this is floated upon a six per cent. solution of bichromate of potash, to which a little sulphuric acid has been added, for about a minute.

"When dry, the paper is exposed under a negative for a sufficient time, the image produced being visible and capable of examination from time to time by opening one of the covers of the printing-frame. A piece of pigment paper of any desired tint is then put into a two per cent. bath of bichromate of potash, together with the printed transfer-paper, and the two are withdrawn in contact, and scraped with a squeegee, to ensure perfect adhesion.

"In this condition the prints are allowed to remain pressed together between sheets of blotting-paper under a weight, for a period of from eight to ten hours. Surfaces placed in contact in the evening may be developed next morning; and the more prints there are, the more chance there is of success, for they must not become dry whilst in contact; and it is well, of course, that all the prints pressed at one time should be of the same dimensions.

"Under this slight pressure a continuation of the solarization goes on by transmission; for when the pigmented tissue comes to be developed, the picture appears fully printed, or toned, if you like, and in its right aspect upon the transfer-paper. The development of the prints is conducted in warm water at 40° to 50° Centigrade.*

"The washing away of the gelatine and pigment is aided by a fine brush, or, better still, by letting the print remain face downwards in the warm water for a period sufficient for its complete removal. In this way the half-tones are secured in their most perfect condition, for there is neither transfer nor reversal of the image. The development takes place from the face, and not from the back, of the image, as is the case in the transfer process; therefore the half-tones remain adherent to the paper in all their integrity, exactly in the same way as in silver printing.

"Although the photometer is no longer an object of the first importance in this process, it is, nevertheless, very useful, because the image is very pale when seen upon the paper, and the limit of exposure is easily exceeded. By using a photometer the pose may, of course, be limited with the greatest nicety, for a preliminary essay will point out the degree upon the photometric scale to which the exposure to light should be pressed."

It will be noted that no reversal of the negative is necessary, which is a great advantage.

MOUNTING PRINTS.

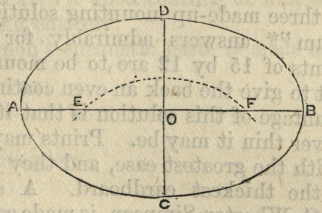
More care than is usually bestowed is necessary to mount prints, whether produced by the silver printing, or the permanent pigment processes. When silver prints are taken from the drying line they are found to be rolled up, and slightly cockled, it may be, in parts; in this state it is difficult to mount them. The method of *stroking* prints has been introduced to get rid of these defects. A flat piece of hard wood, about one foot long and one and a-half inch broad, and the thickness of a marquoise scale, has its edges carefully rounded off. The print is seized by one corner in one hand, and unrolled; the face of the print is brought in contact with a piece of plate-glass. The "stroker," held by the other hand, is

* About 100° to 120° Fahrenheit.

brought with its rounded edge on to the back of the print near the corner held by the first hand. Considerable pressure is brought upon the stroker, and the print is drawn through between it and the plate. The print is then seized by another corner and similarly treated. By this means a gloss is put upon the print, and the creases and cockles are obliterated. The print is now ready for cutting out.

It is well to have squares of glass with true edges cut to the size of the pictures generally taken. The prints should be trimmed upon a sheet of plate glass, a sharp penknife being used to cut them. A rough test for ascertaining if the opposite sides are equal is to bring them together and see if both corners coincide.

It may sometimes be found useful to cut out a print into an oval. The following method for tracing any ellipse may be employed:—On a thickish piece of clean paper draw a line AB,



making it the *extreme* width of the oval required. Bisect it at O, and draw DOC at right angles to AB. Make OC equal to *half* the smallest diameter of the ellipse. With the centre C and the distance AD draw an arc of a circle, cutting AB in E and F. Place the paper on a flat board, and at E and F fix two drawing pins. Take a piece of thread and double it, knotting it together in such a manner that its length when doubled is equal to AB. Place the thread round the two pins at E and F, and stretch it out to tightness by the point of a lead pencil. Move the pencil guided by the cotton, taking care to keep it upright. The resulting figure will be an ellipse. Modifications of this figure may be made by making a second knot beyond the first knot, and placing the point of the pencil in the loop formed. When the figure has been traced in pencil on the paper, it should be carefully cut out with a sharp penknife, and placed on the print which is to be trimmed into an oval. When so placed, a faint

pencil line is run round on the print, and the cutting out proceeds either by scissors or penknife.

There are a variety of mounting solutions in common use, the most favourite being starch. This is prepared in the ordinary way, and is laid on the back of the print by a hog's-bristle brush. Starch is dangerous to use, unless perfectly pure and fresh. It is apt to liberate acid, which will destroy a print in contact with it.

To prepare gelatine for mounting, take half a wine-glass full of gelatine, and cover it with cold water; when thoroughly swelled—which will be in about three-quarters of an hour—pour off any water that has not been absorbed, and fill up the wine glass with boiling water. The gelatine will now be dissolved, and will remain fluid if the wine-glass be kept standing in warm water. This mounting medium is applied in the same way as the starch. Very thin glue is also occasionally employed, and answers well. In the market, at the present time, there are two or three made-up mounting solutions. "Marion's Mounting Medium"* answers admirably for small pictures, though when prints of 15 by 12 are to be mounted, it is apt to be rather difficult to give the back an even coating before it dries.

One great advantage of this solution is that it does not cockle the mount, however thin it may be. Prints may be mounted on foolscap paper with the greatest ease, and they will be as flat as if mounted on the thickest cardboard. A similar solution, suggested by Mr. G. Wharton Simpson, is made as follows:—Take gelatine or fine shreds of glue, and swell them with the least possible quantity of water. Boil them with alcohol, keeping them in agitation with a stirring rod the whole time. Eighty grains of gelatine will take about two ounces of alcohol to render it of a fit consistency for mounting. When cool the solution will become gelatinous. It can be used for mounting by letting it stand in a pot of warm water.

Before applying the mounting solution, the places where the corners of the print will come on the card should be marked with fine dots. The back of the print, having then been brushed over with the mounting solution, should be carefully placed on the mount, the corners coinciding with the dots. A piece of white blotting-paper should next be placed over the print, and the back of the print should be brought in close contact with the mount

* To be obtained from Messrs. Marion, Soho Square.

by rubbing the clenched hand over the blotting-paper. To obtain great evenness a piece of white cream-laid paper may then be placed over the print, and the edge of an ivory (or other smooth substance) paper-knife be scraped briskly over it. This adds a brilliancy to the print, and prevents cockling in a great measure when starch or gelatine is used, all excess being squeezed out.

The print is ready for rolling after the mounting solution is well dried. Finally, the surface of the mounted print should be waxed. There are various formulæ for the encaustic, the simplest being :—

White wax	1 ounce
Spirits of turpentine	1 ,,

the solution taking plainly by the aid of heat.

Mr. Valentine Blanchard uses white wax dissolved in benzole. This, he states, leaves a good coating of wax on the print, the benzole evaporating entirely.

M. Adam Salomon's encaustic paste is made as follows :—

Pure virgin wax	500 grains
Gum elemi	10 ,,
Benzole	½ ounce
Essence of lavender	¾ ,,
Oil of spike...	1 drachm

The waxing solution may be taken up by a tuft of cotton wool and spread roughly over the surface of the print. A clean pad of cotton wool is then used to rub it well in, till the surface assumes a bright gloss and is free from all appearance of markings. For increasing the depth of shadow and general beauty of a print waxing is of the greatest utility.

PHOTO-MECHANICAL PRINTING.

All photo-mechanical printing processes for production of half-tone hitherto worked out are based on the same principle as the carbon or autotype process; viz., the insolubility in water (either hot or cold) of gelatine impregnated with a bichromate of an alkali, after exposure in a dry state to the action of light. Not only is insolubility produced, but also an inability to swell through the absorbtion of water. There is one

other method of producing insolubility in gelatine, though not to prevent the absorption of water, viz., the addition to it of chrome alum, tannin, bichloride of mercury, and various resins. These render the gelatine tough, and capable of withstanding a large amount of wear and tear.

Now if a layer of gelatine to which has been added bichromate of potash and (say) chrome alum be exposed to light under a negative, and subsequently immersed in water, a little reflection will show that it is *all* insoluble in water; that where light has acted, there it will refuse to swell by the absorption of water; that where light has not acted, there it will absorb water. If a roller holding greasy ink be passed over the surface, the ink will be repelled from all the swelled portions (see page 123), whilst it will adhere only to those parts on which light has acted. If a piece of paper be pressed down on such an inked-in surface, it is manifest that we shall obtain a positive print on its removal. With half-tone subjects the ink will only take in exact proportion to the intensity and time that the light has acted on the gelatine surface.

THE HELIOTYPE PROCESS.

This process is patented, and belongs to the Heliotype Company, of 1, Old Palace Yard, Westminster, who grant licences for its working.

In the heliotype process a film of gelatine is prepared on a glass plate, from which it is stripped when dry, and printed in the ordinary manner under the negative. The proper preparation of the film is of the highest importance, and unless properly performed the resulting prints will be imperfect.

The glass plate should be perfectly flat, and finely ground* on one side. To prepare it, the ground side is waxed with a waxing solution of white wax dissolved in ether. This is applied plentifully to the plate with a soft rag or cotton wool, and rubbed well in. As much as possible is then removed with a little ether or spirits of wine, till the surface presents an even and almost polished appearance. When required for use, the waxed surface of the plate is levelled by means of a spirit-level.

* The polished surface of the glass may be employed by coating it with plain collodion containing equal parts of ether and alcohol, and about seven grains of pyroxyline, giving a horny film.

The following formula may be used in the preparation of the "skins" of gelatine, for plates 22 by 16 :—

No. 1.—Gelatine		1½ ounces
Glycerine		1 drachm
Water		12 ounces

The gelatine, which answers well, and is cheap, is Nelson's No. 3 Flake. It should be allowed to swell in the water, and, when thoroughly swollen, should be melted over boiling water, and then the glycerine added. The temperature of the gelatine should not rise above 115° F., and the solution should be stirred till a perfectly even fluid is produced.

The sensitizing solution is made as follows :—

	For Summer.	For Winter.
Bichromate of potash ...	22 grains	30 to 40 grains
Chrome alum	15 ,,	15 to 7 ,,
Water	12 drachms	12 drachms

This quantity, after heating to 100° F., is added to the prepared gelatine solution immediately before use; in fact, it should be added in the vessel from which the plate is to be coated, and stirred well, to form a perfect mixture. A piece of muslin is tied over the top of the vessel, and the gelatine allowed to strain through it on to the levelled plate. The surface having been covered, and the gelatine allowed to set, the plate can be placed away from all dust in a drying room through which a current of air of about 75° is passing. The plate gradually dries after twenty-four to forty-eight hours. It will keep sensitive on the plate for a week or more. The drying-room should be glazed with deep orange glass, and be well ventilated.

Another formula is appended, which has the advantage of giving an opaque white film :—

No. 2.—Gelatine	2 ounces
Glycerine	3 drachms
Water	9 ounces

This is prepared as before, but, just before use, and before adding the sensitizer, five ounces of skimmed milk (which has been warmed, to cause the cream to rise) are stirred up with the solution. The sensitizer is then added as before.

	For Summer.	For Winter.
Bichromate of potash ...	22 grains	30 grains
Chrome alum	7½ ,,	5 ,,
Water	12 drachms	12 drachms

When dry the skins are stripped from the glass plate, the edges being raised by a penknife. It is best to allow them to stay for half an hour in a place where the temperature and moisture are similar to that to which they will be subjected during exposure. This will prevent any danger to the negative in the printing-frame. The skin is next placed, with the surface which was not in contact with the plate uppermost, on a board on which has been nailed black velvet. Two small strips of the skin are cut from its edge, and placed one over the other in an ordinary printing-frame, with an opaque mask over them, in which is cut a lozenge-shaped hole. This is exposed to the light with the skin. When the image of the hole is seen well defined on the nethermost strip of gelatine, the skin is withdrawn, and its surface which was in contact with the glass placed in contact with a *reversed* negative in a printing-frame. (It is advisable that all the skin excepting that under the negative should be masked, to prevent the light acting on it.) One of the ordinary actinometers, prepared with yellow oiled-silk, is now brought into requisition. In the figure each number denotes the number of thicknesses of the silk; hence, when on a strip of sensitive gelatine 6 is seen, the light has penetrated through six thicknesses; when 7, through seven thicknesses, and so on. A half-tone negative of ordinary density will require the number 10 to be read on a piece of the sensitive gelatine placed beneath it; a clear line subject, not more than 6 or 7. Of course the actinometer is exposed in the same light as the frame (a small carte-de-visite pressure-frame is convenient for holding the actinometer). When a negative is weak, it may only be half printed, and the continuating action (see page 103) allowed to act for twelve to twenty-four hours, when a more brilliant result will follow. In this case the preliminary sunning of the skin should be lessened, for obvious reasons.

3	4	5	6	7	8	9	10	11	12

Preparing the Transfer Plate.—A smooth metal plate of slightly larger dimensions than the skin (by preference pewter or nickelled steel) is coated with a solution of india-rubber in benzole, of the consistency of thick collodion (ordinary rectified lamp benzine answers every purpose); this is allowed to dry. The skin is then placed in water with the prepared plate beneath, for two or three seconds, and both are withdrawn,

leaving a layer of water between the sunned side of skin and the coated surface of the plate.

A large squeegee is next brought to bear, and the two surfaces brought in close contact, as in the double transfer carbon process (page 98). If any dust be between the two surfaces, great danger is run of blistering. When squeegeed down, the edges are brushed round with india-rubber solution, to prevent the water penetrating underneath and raising them. When the india-rubber is nearly set, the plate is immersed in water for periods varying from ten minutes to one hour.* When all the bichromate is washed out, the surface of the skin is wiped dry, and is then ready for printing.† Blisters may now be apparent from dust or bubbles in the film; these can generally be forced out by applying the flat part of the hand, and squeezing them out to edge.

Printing from the Gelatine Picture.—The plate is now laid on the bed of a printing-press, and small strips of paper are pasted with india-rubber over the edges of the skin on to the plate. A piece of bibulous paper is placed on the skin, and a good hard pressure brought to bear; this squeezes out most of the superfluous water, and leaves the plate ready for inking. Best lithographic chalk ink‡ should have been prepared with green oil, and be of the consistency of soft wax. The gelatine or india-rubber roller should be coated with this ink by rolling on a stone slab or slate. When coated, the roller is applied, evenly and smoothly, to the plate. Those portions acted upon by light will take the ink, whilst all others will repel it. If the picture be a half tone one, a thinner ink of any colour made up with oil or Russian tallow may be used on another roller. This roller will not rob the plate of the first, on account of the thinness of the second ink, but will supply detail in the high lights. Paper is now placed on skin, and, with a moderate pressure, a proof is pulled. Should white margins be apparent round the blackest shadows, or if the relief of the plate be too great, it is a sign that the surface requires "smashing down." This is done by placing bibulous or enamelled paper on the skin, and bringing down the platen of the press with a great pressure. This gradually diminishes the relief. More ink is applied, and proofs are

* For a skin prepared according to No. 2 formula, ten minutes are sufficient.

† Should a collodionized surface have been used, care must be taken that all the collodion is detached before printing. These polished surfaces have great advantage, having no grain.

‡ *All inks* should be *very* finely mulled.

pulled till satisfactory results are obtained. The surface of the skin between each proof pulled should be slightly damped with a sponge, and the excess of moisture got rid of* by the squeegee and blotting-paper. This keeps the whites clean as in lithography, and gives pluck to the resulting picture. Should the whole of the picture be too deeply printed, a little dilute ammonia (one part to four of water) may be sponged over the surface till the over-printing is no longer visible. In order to keep clean margins to the prints, a mask is cut of the shape required. The mask paper is prepared as follows:—Stout bank post is laid flat on a board, and boiled linseed oil is brushed over it. It is hung up by clips to dry, and is then ready for use. The mask of course is turned back between each inking-in of the picture.

Paper.—Any kind of paper may be used with "milk" skins, whilst enamelled paper answers best with the ordinary ones. The enamelled paper is prepared with "mountain snow" and gelatine; it is the subject of a patent, and hence cannot be manufactured excepting by licencees of the Heliotype Company. Of ordinary paper, that answers best which is found most adhesive when the tip of the tongue is applied to its surface.

Varnishing Prints.—The prints may be varnished, after pulling, if thought necessary, by a water varnish. This is made by dissolving shellac in boiling water to which a little ammonia has been added. As the shellac dissolves, more is added, stirring the solution the whole time. From time to time more ammonia and shellac must be added, till the varnish, on drying, leaves a brilliant surface. The varnish is filtered, and applied to the print with a flat brush.

Preparing the Gelatine Rollers.—The rollers are made of a solution of gelatine to which glycerine and castor oil are added. They are moulded in a cylindrical mould, on perforated wooden rods, similarly to the manner of preparing ordinary printing rollers. A roller for a first ink is coated with gold size and the fluff of blotting-paper; a second ink roller remains with the gelatine surface to take up the ink. India-rubber rollers can also be obtained, which answer well. The great secret of producing a good heliotype is to have first-rate rollers at command.

* This should be done as quickly as possible, as, if not, the film is apt to become unequally damped, and give an unequal print.

Failures.—The usual source of failure is the skins, which are not kept sufficiently free from dust, and in which air-bubbles are to be seen. In winter, blisters will appear from the above causes, as well as from too low a temperature of the water. The washing water should never be below 60°. If a skin be over-sunned, or be kept too long after sunning, a scum of ink will invariably be apparent on the high-light. If a picture be over-printed under the negative, it may often be corrected by the judicious application of ammonia, as given above. If it be under-printed, thinner inks may be tried; but it is better to print a fresh skin than to waste time over experiment. Imperfections in the prints often arise from the imperfect use of the squeegee and blotting paper, and from an uneven coating of the rollers with ink.

CAPT. WATERHOUSE'S PHOTO-MECHANICAL PROCESS.

All other kinds of photo-mechanical processes are, it is believed, those by which the gelatine film is printed from without removal from the glass plate. Captain Waterhouse's *modus operandi* is here given, as it is simple, and has proved most effective.

The negative must in all cases be reversed as for the heliotype process, unless recourse be had to printing by contact, as with the Mariotype process. (This method answers equally well with the heliotype process.) Plate glass three-eighths of an inch in thickness is used; it is ground on one side. When required for use, it is carefully cleaned and levelled in the ordinary manner. (Small wedges of hard wood answer well for this.) The gelatine solution, made as follows, is poured on the plate:—

1	Gelatine	1 ounce
	Sugar...	1 drachm
	Distilled water	6 ounces

The gelatine must be allowed to swell, and be then dissolved.

2.	Honey soap*	30 grains
	Distilled water	1 ounce
3	Tannin	10 grains
	Distilled water	1 ounce

* Calvert's medical carbolic soap answers well, and prevents decomposition of the film.

The above quantities suffice for two square feet of plate.

When No. 1 is ready, Nos. 2 and 3 are mixed together hot, and poured gradually, with constant stirring, in No. 1.

The whole is then strained through two thicknesses of coarse cotton cloth, and poured evenly over the plates. (It is as well to let a very little run over the sides, as it secures adhesion of the gelatine to the surface.) Bubbles are broken by the point of a penknife. The plates are then covered over with a light paper cover, to prevent dust falling on them. They will set in this country in about ten minutes time, when they should be turned over and allowed to dry, face downwards, being supported on blocks of wood at the corners. Drying may also be carried on as for the heliotype process. When they are dry, they are ready for sensitizing; this is done by immersing them in

Bichromate of potash	1 part
Water	20 parts

for about five minutes, when they are re-dried. (If the same proportion of the bichromate salt be added to No. 1 as given in the heliotype process, this re-drying may be avoided). When dry, any deposit at the back of the plate, and inequalities at the corners, are removed, and the plate is ready for exposure to light.

"This operation is performed in a pressure-frame in the same way as for ordinary photographs. It is advisable, however, to secure clean margins by shielding the borders of the negative by means of a mask cut out in yellow or brown paper, which should well overlap the edges of the printing plates. The mask is laid on the glass of the pressure-frame, then the negative in its proper position (should this be a transferred film, it is advisable to place a glass plate between it and the mask, in order to secure the most perfect contact); the sensitive plate is then rubbed over with a little powdered soapstone, to prevent its adhesion to the negative, and adjusted in its place over the negative, covered with a sheet of black velvet or brown paper, over which a thick glass plate is laid, and, if necessary, a few sheets of thick paper to give a good strong pressure, when the bars are shut down. The thick plate of glass has been found to give much sharper and more even contact than the usual backboard.

"The amount of exposure to light varies from about ten minutes

in the sun for a clear line subject to from twenty-five to fifty minutes for a subject in half tones, according to the subject and intensity of the light; but, as it is impossible to judge of the progress of the printing by inspection, it is necessary to use an actinometer as a guide to the exposure (see page 112).

"When the exposure to light is considered sufficient, the negative and mask are removed, and the *back* of the sensitive plate is then exposed to light for about five or ten minutes, to thoroughly harden the gelatine, and prevent it from swelling too much in the after processes. It is as well to carry on this second exposure under a piece of ground glass, otherwise, if there should be any scratches on the back of the sensitive plate, or on the glass of the pressure-frame, they will show as white lines on the print; after this the plate is taken out of the frame, a little tallow is rubbed round the edges to prevent water getting underneath and stripping the film, it is then plunged in water and thoroughly washed till all traces of bichromate have been removed, and is ready for printing.

"*The Printing*.—The plates may be printed in the lithographic press, and then require to be fixed on a level stone with plaster of Paris. It has been found, however, more convenient, and in other respects better, to print them with vertical pressure in the ordinary Albion press; and in order to prevent their being broken, the bed of the press is fitted with two or three thicknesses of kamptulicon, besides a sheet of vulcanized india-rubber on which the plate rests. It is also desirable to place a sheet of white paper over the bedding, in order to enable the state of the plate, when it is being inked up, to be better seen.

"The plate, having been well soaked in water, is laid on the press, and, after being wiped, to remove the excess of moisture, is inked in, if a line subject, with an ordinary lithographic roller charged with an ink composed of lithographic chalk ink thinned with a little olive oil, followed by a rolling with a smooth roller to clean away the superfluous ink; a mask of the required size is laid on the plate, over this comes the printing paper covered with a piece of soft felt to drive the paper well into the hollows of the plate, the tympan is lowered, and the impression pulled in the ordinary way. The plate is then damped, and the work goes on in the same manner without difficulty.

"For printing in half tones, however, the process is some-

what different, and to obtain uniformly successful results requires considerable skill and experience. As far as we have gone the following procedure has given the best results.

"The plate is first inked in by means of a small leather hand-roller charged with stiff ink (rendered stiffer, if necessary, by the addition of a little Canada balsam) which takes only on the deeper shadows; the half tones are then brought out by rolling in with a smooth lithographic roller charged with a lighter and softer ink. Rollers composed of glue, treacle, soap, and catechu have been found useful in certain cases for inking in the plates, but, on the whole, the lithographic rollers are preferred. The impressions are best when printed on enamelled paper, but a smooth glazed printing paper also seems to answer well.

"Before putting away the plates after printing, they are washed with turpentine, followed by a very weak solution of caustic potash, to remove all traces of the greasy ink; they may also be treated after this with a mixture of gum and glycerine with advantage.

"*Corrections.*—A point that seems likely to greatly interfere with the extended use of the process was the difficulty of making corrections on the plates. I am glad to say that some experiments lately tried have shown that it is practicable both to insert and to take out or clear up details on the gelatine films.

"The insertion of details may be accomplished by two or three methods. The first is by writing in the required additions on the dry plate with a pen or fine brush, using an ink composed of bichromate of potash, used alone, or slightly coloured with Indian ink or indigo. After the additions are completed, the plate is exposed to the light for ten minutes or a quarter of an hour, till the bichromate is thoroughly reduced, and may then be washed and printed as usual. In some cases the same object may conveniently be accomplished by brushing over the part with solution of bichromate of potash, allowing it to dry, and then printing in the required details from another negative.

"Experiments have shown that details may be taken out by the aid of a solution of caustic potash or cyanide of potassium; and should a plate print dirty, it may be cleaned up and greatly improved by the use of a weaker solution of the latter substance.

"It often happens that the plates show too much relief in the lights, and that the ink will not take readily on the shadows or lines represented by the deepest hollows. This relief may be reduced by brushing the plate over with dilute nitric acid, one-sixth or weaker. The plate is then washed, and on inking-in the ink will take readily in the lines or hollows."

PHOTO-LITHOGRAPHY AND ZINCOGRAPHY.

PHOTO-LITHOGRAPHY is an important branch of photography, where the rapid copying and multiplying of line subjects is in question, and requires much care and dexterity to carry out. It is rarely to be found that the process is worked satisfactorily by a beginner, but that constant attention will render it practicable.

What is required is to obtain a print* from a negative in greasy ink, which may be laid down upon the ordinary lithographic stone or zinc plates. The principles of the process are the same as for the Autotype process, previously described at page 59.

SOUTHAMPTON PLAN FOR PREPARING TRANSFERS.

Make the following mixture:—

Bichromate of potash	2 ounces
Nelson's fine-cut gelatine	3 ,,
Water	50 ,,

The bichromate is dissolved in ten ounces of water, and added to the forty in which the gelatine† has been previously dissolved by the aid of heat. Select some good bank-post paper (very grainless) of a medium thickness. If this cannot be obtained, get ordinary thin paper as a substitute, and cut it into sheets a little bigger than the negative to be printed from. Strain the solution and pour it into a dish through flannel,

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* Called a transfer.

† The gelatine should soak in water just sufficient to cover it, and then the remainder of the water should be added in a boiling state.

keeping up the temperature. This is best attained by getting a tin dish made, standing on four legs. (The dish holds water, which can be heated up to boiling point by a spirit lamp; and on the top of this should rest the porcelain dish containing the solution.)

The paper is floated about three minutes, and hung up by two corners to dry in a room which is non-actinically lighted, and is perfectly free from dust. When dry, the paper must be floated again as before. The sheets should be hung from the opposite corners to those by which they were hung after the first floatation. Should it be considered desirable to coat the paper with gelatine first, and then sensitize, the bichromate may be omitted from the foregoing formulæ. The sensitizing is then effected by floating the prepared paper for one minute on a cold solution of—

Bichromate of potash	1 ounce
Water	15 ounces.

In both cases it is well to pass the sensitized paper through a copper-plate or lithographic press, to obtain a fine, smooth surface.

The sensitized paper will keep from about a week in cold weather, to one day in hot.

The negative must be perfectly opaque in the whites, and transparent in the lines; no clogging or deposit must be apparent on them. It will be found that great pressure is required in the printing-frame to bring the paper and the negative in close contact throughout. The difficulty is increased considerably if the plates are not perfectly flat; hence, for these negatives, patent plate is recommended.

The amount of exposure to be given requires great judgment. With paper of a most sensitive character, a negative extremely dense in the whites, and the lines perfectly transparent, from half a minute to two minutes will be found sufficient if exposed in bright light, whilst it may take an hour in dull weather. The surest indication of proper exposure is when the lines appear a dark reddish-brown on a yellow ground. Should a negative be weaker in some parts than in others, the weak parts may be shaded by tissue paper, or paint applied on its film side.

The prints have now to be coated with greasy ink. At Southampton the following formula of preparation is used:—

Lithographic printing ink	8 ounces
Middle varnish	4 ,,
Burgundy pitch	3 ,,
Palm oil	½ ounce
Wax	½ ,,
Bitumen	1 ,,

The ink and varnish are first ground well together with a muller on a stone slab. The Burgundy pitch is next melted over a clear fire till the water is driven off. The wax is next added to it in small pieces, and finally the palm oil. These are well stirred together. When properly melted, these should catch fire if a light be applied to them, in which case the bitumen is added, and it is afterwards ignited again. The ink and varnish are now added little by little, the stirring continuing the whole time. The pot is now taken off the fire, and when the contents are cooled they are poured into tins for storage. The condition of the ink is of the greatest importance. It must not be too soft, otherwise the sponge will become clogged on washing off in development. If the ink be too hard, it will be difficult to wash it off from the paper at all; in this case more palm oil should be added.

A small quantity of the ink should be taken, and laid upon a flat stone slab, and melted with turpentine sufficient to give it the consistency of honey. This is well worked with a lithographic roller on a smooth stone or square plate to a fine even surface. A print is now taken and laid face downwards upon this inked stone, and is passed once or twice through the lithographic press. On carefully raising it, it will be found to have taken a fine layer of ink, through which the detail will be faintly visible by transmitted light. The coating of ink may also be given by a sponge or hand roller, the paper being pinned firmly on to an even board, face uppermost. The finer the layer of ink, the better will be the developed print. These operations should, of course, be carried on in non-actinic light.

The print is now *floated*, *face uppermost*, on water of about 90° Fah. It is allowed to remain on this till the lines are seen in bas-relief on a swollen-up ground. It is next transferred to a zinc or glass plate placed on the slope, when warm water of about 150° is poured gently over it, and the soluble gelatine is removed by *gentle* rubbing with a very soft sponge. Should the inked soluble gelatine not leave the paper

entirely at this stage, the prints should be *soaked* in warmer water for about an hour, when the sponging should be repeated. When the sensitized gelatine is moistened it becomes insensitive, consequently these operations may be performed by ordinary daylight. It should be borne in mind that the utmost care is required in the sponging: if the sponge be roughly handled the fine lines will be removed, and spoil the print for transfer. It should also be recollected that a constant flow of water from the sponge must be kept up to remove the inky gelatine after it is loosened, otherwise stains may result.

The prints, when freed from the soluble gelatine and ink, should be well washed in dishes of cold water, and hung up to dry. They are now ready to transfer to stone or zinc. It is better to leave them a day, however, before the transfer takes place.

TO MAKE A TRANSFER BY PAPYROTYPE.

This process is one patented by the writer, and is very simple of operation. Any tough paper is coated with a fine layer of gelatine, and subsequently treated with chrome alum or alum. It then receives another coating of gelatine of the same formula given for the Southampton method, substituting flake gelatine (for cheapness' sake) for the fine cut. The printing is not carried on to such an extent as in that method, but the lines must appear of a delicate fawn colour on the yellow background. After withdrawal from the frame the print is drawn through *cold water*, and is then squeegeed down on to a smooth zinc or pewter plate. If found necessary, the edges may be secured by strips of paper and india-rubber solution, as for the heliotype process. The superfluous water is then blotted off. A gelatine roller (of not too adhesive a character) is then charged with ink by rolling on a slab made as follows :—

Best lithographic chalk ink	4 parts
Palm oil...	1 part

This is now rolled on to the paper. The gelatine has only absorbed water where it has been unacted upon by light; consequently the print alone will take the ink, the "whites" remaining free. After the paper has been well charged with ink, it may be necessary to pass the roller smartly over the surface to remove any scum that may be adherent. The finished

transfer will be found of the most delicate character, and surpasses in sharpness any one produced by other known methods. It is essential that but very little of the bichromate of potash should leave the paper, as the success in transferring mainly depends upon its presence. The transfer print is hung up to dry, and is then again exposed to light. The whole surface now becomes insoluble, and on redamping, previous to placing on the stone, it has no tendency to stick, nor will the gelatine be squeezed away by the pressure of the scraper in the press. There will still, however, be sufficient adhesiveness left to retain the paper in position. It will be noticed that this process has the following advantages:—

1st. The ink which forms the lines is not left on ridges of gelatine, as in the Southampton method.

2nd. There is no danger of removing the ink from the fine lines.

3rd. The ink may be applied till a satisfactory result is obtained.

4th. Two inks may be used of different consistencies; the thick ink will give solidity to the thick lines, whilst the fine lines will take a thinner.

5th. The surface of the transfer will have no tendency to slip, as the whole is partially adhesive.

It is not proposed to give a detailed description of the apparatus for lithography or zincography, as any respectable manufacturer will supply them of a proper character. A list of the articles necessary to procure is given at the end of the book.

Both lithography and zincography depend on the property that a calcareous stone or mulled zinc plate possesses for absorbing or holding water, and on the fact that the grease is repelled by water; thus, where there is grease on a stone or zinc plate (placed by accident or design) the water is repelled. If a roller now be charged with greasy ink, and passed over the surface while still damp, the greasy ink will "take" in those portions where grease was originally on the surface, whilst the other portions remain unaffected. (The slightest trace of grease on the plate is sufficient to attract the ink from the roller.)

TO PREPARE A STONE FOR LITHOGRAPHY.

To prepare a lithographic stone for taking the transfer from a drawing, should the surface be uneven, or if a drawing has previously remained on for a considerable time, it may be

necessary to grind it down, either by a stone of great size, or by an iron levigator. In both cases fine silver sand is sprinkled between the two surfaces, moistened with water. When the old work is removed, and the surface level, it is thoroughly washed with clean water and polished with soft pumice stone. The pumice stone is moved backwards and forwards till all grain is removed. It is again washed with a sponge and water, and finally brightened up with snake stone. After washing it is allowed to dry, when it is ready to receive the transfer. The whole of the polishing with pumice and snake stone will take about a quarter of an hour.

TO PREPARE THE ZINC PLATES FOR ZINCOGRAPHY.

The zinc plates are supplied by manufacturers, of proper weight and ready planished. They should be about 10 B W guage. To be prepared for receiving a transfer, they must be grained. Brass founders' moulding sand is the best form of sand to use, as others, particularly silver sand, is apt to scratch the plate. Prior to use, it is sifted through a fine sieve of about 160 holes to the linear inch. A zinc muller is used to grind the surface after the sifted sand (moistened to the consistency of a cream with water) has been sprinkled on the surface. It is worked slowly round and round with a spiral motion, till the surface after washing appears of a uniform dull grey tint. Any traces of previous work must be obliterated, and all scratches must be ground out. The mullers should be kept free from all accidental grit, and be carefully washed before use. The zinc plate whilst mulling may be laid on any flat surface. A plate should be mulled immediately before use.

TRANSFERRING TO STONE OR ZINC.

The stone is slightly warmed either before a fire, or, what is more expeditious, by pouring over the surface a kettleful of boiling water. The heat in this case dries the stone, and leaves it sufficiently warm. The transfer is slightly damped, either by a moist sponge, or by damping a sheet of blotting-paper and placing it at the back. In any case, the top surface of the transfer should not be sponged or greatly damped.

Whilst this is taking place the stone is placed on the bed of the press, and it should be ascertained that the scraper is perfectly true. Should it not be so, it may be adjusted by placing a piece of sandpaper on a perfectly flat surface, and rubbing it

down till it is perfectly level. The stone should now be "pinched" by the lever between the bed and the scraper, a piece of clean paper protecting its surface from the leather tympan. If the same amount of pinch be apparent at all parts of the stone, it is ready for use. If one end have less pinch than the other, the former must be raised up by laying under it a few folds of paper, taking care that the folds gradually taper off as they approach the centre of the stone. When adjusted thus the stone must be passed two or three times through the press, to cause a still more accurate adjustment of the transfer. The transfer is then laid on the stone by two corners, and a couple of sheets of paper are laid over it. The tympan is brought gently down, and the whole is passed through the press two or three times. The amount of pinch given should be light for the first pull, it being increased for each subsequent one. The tympan is now raised, and if the transfer adhere tightly to the stone the scraper may be reversed, and the stone is passed through the press a couple of times more. In order to remove the transfer paper it may be necessary to soak it with water. This done, the surface of the stone is moistened with gum-water, and allowed to dry and cool. This is most important, as if it be used too fresh or whilst warm, the lines may spread, and give coarse and broken work.

The stone is fixed on the press, and the gum is washed off with a soft sponge, and the moisture distributed with a damping or cheese cloth. Ordinary litho ink having been worked to the consistency of honey, a little is laid on the roller and worked about on the ink slab till a fine even layer is spread over its surface. *Whilst the stone is moist* the roller is passed over it from time to time, that fresh surface may be brought to bear on the work. By this procedure it will be found that the lines take the ink. If a slight scum appear whilst rolling, it is probable that the stone is not sufficiently damp. A fresh application of the sponge and damping cloth, and a smart roll, will lift it, leaving the surface clean. The stone is next slightly etched, to prevent spreading of the lines. A very dilute solution of nitric acid in water effects this. A sponge moistened with this should be passed over the surface, and after leaving it for two or three seconds, fresh water should be applied with the damping cloth. A little gum-water is then applied, wiped off, and the

* When the work is weak, sour beer may be substituted.

inking proceeded with again. It may happen that all portions will not take the ink alike—that portions are weaker than other; in this case, over those parts should be spread thick gum, and *through* it should be rubbed a little palm oil, spread on a small square of cloth. This *generally* gives the required intensity. Impressions are now pulled, inking in between each.

For zincography the process is very similar; the transfer is damped and passed through the press as above, the zinc plates being screwed on to a flat block of hard wood, so as to lie evenly and of sufficient height on the bed. When the transfer is removed the plate is well washed, and fanned dry. An etching solution is made thus—

Decoction of galls	...	...	1 quart
Gum-water	...	...	3 quarts
Phosphoric acid	...	...	3 ounces.

The decoction of galls is prepared by soaking four ounces of bruised Aleppo galls in three quarts of cold water for twenty-four hours; the water and galls are then boiled together and strained. The phosphoric acid is made by placing sticks of phosphorus in a bottle of water so that the ends of the sticks are exposed to the air. The etching solution is brushed on the plate with a broad brush, and allowed to remain a few seconds; the excess is then wiped off with a cloth, and the zinc plate is fanned dry. It is then washed and rolled up as before. The first few impressions, either from stone or zinc, are generally feeble, and must be rejected.

A GUM PROCESS.

Take Rive paper, and brush over it a solution of

Picked gum-arabic	...	...	25 grains
Bichromate of potash	...	...	85 ,,
Water	...	...	1 ounce.

Hang it up to dry. This will be accomplished in about half-an-hour in warm weather.

The sheet of paper must be placed under the negative as usual, and exposed to the light. When every detail is clearly seen, the paper should be withdrawn.

Take ordinary printing paper, and soak alternate sheets in water, blotting the excess of moisture off in blotting-paper. Make these in a pile (about six sheets of moist and dry will be sufficient). Place the printed paper on the lithographic stone,

or sheet of mulled zinc, place a dry sheet of paper on its back, and then on it place the pile of damped paper. Finally, place a sheet of zinc or other flat surface on the top. The stone or zinc plate and its load should next be pressed under an ordinary book-binding press, and a considerable pressure brought on to it. It should be left under this for half-an-hour.

The paper is then removed from the stone. Those parts of the gum which were rendered insoluble will leave the stone with the paper, the remaining portions adhering to it. After thorough drying away from light, a little oil is poured or brushed over the surface. The gum protects the white portions of the print from its action. The stone may be cleaned from the gum with a sponge and tepid water, and the ordinary lithographic process may then be proceeded with.

The process is simple, the drawback being that the gum penetrates to a considerable depth through the surface of the stone, rendering the preparation for fresh work tedious.

SOME SPECIAL APPLICATIONS OF PHOTOGRAPHY.

INSTANTANEOUS WET PLATE PHOTOGRAPHY.

The term "instantaneous" is merely a comparative term, and must be understood as expressing simply a *very* short exposure. In photographing street scenes, &c., short exposures are of the greatest use, and there are frequently occasions in art photography in which an accurate knowledge of the conditions for obtaining instantaneous pictures is essential.

The plates must be excessively clean, as the shortness of the exposure and the strength of the developer used render the slightest chemical dirt apparent.

A collodion containing a large amount of bromide is generally used, and it should be of a straw colour to give the best results. The addition of 1 to 1½ grains of bromide to the ounce of ordinary bromo-iodized collodion will answer as a rule. It is recommended that the different samples of iodized collodion in stock should be tested one against the other, by means of the cut stereoscopic plate (as described at page 15), and the most rapid and delicate selected.

A newly-prepared bath (or nearly so) is an essential: the

40-grain (as described in page 16) will answer; a 50-grain bath will, however, ensure better results. With a highly-bromized collodion, the addition of a drop of concentrated nitric acid to the ounce of bath will often aid sensitiveness; with a collodion poor in bromide, this addition must not be made. If doubt exist as to the quantity of bromide, the nearly neutral condition of the bath had better be maintained.

The iron developer No. 3 (page 19) is suitable. Two other formulæ are given, both of which are effective.

Protosulphate of iron	60 grains
Water	1 ounce

Or,

Protosulphate of iron	60 grains
Formic acid	1¼ drachms
Alcohol	*quant suf.*
Water	1 ounce

A pyrogallic acid solution has also been used, viz.:—

Pyrogallic acid	20 grains
Formic acid	1 ounce
Alcohol	6 drachms
Water	1 ounce

It is of the greatest importance that the plate should be covered with the developer quickly. It matters little in this case if part of the free silver solution be washed away by the developer; in fact, it is advisable, as the lack of silver prevents too great a reduction on the higher lights before the detail is brought out.

It generally happens that instantaneous pictures require no intensification. If they should require it, the iron and citric acid formula is recommended, as it brings out detail. Care must be taken that harshness is not given to the negative from trying to force out detail, and only really piling up the silver on the high lights without bringing up the half tones.

With dry plates instantaneous pictures can be obtained, though with less certainty than by the wet process. The great essential with these is that they should be freshly prepared, and be raised previous to development to a temperature of about 100° Fah. This may be managed by immersing them in water of that degree of heat. The developer should likewise be warmed to the

same temperature. England's collodio-albumen process has answered well with the writer, the above precautions being taken. With Col. Wortley's uranium dry plates the ordinary mode of development may be adopted, using a larger dose of the ammoniacal solution.

A short-focus lens, having a good defining power with a large stop, should be preferred. A single lens has the additional advantage of having the smallest number of reflecting surfaces. Dallmeyer's Rapid Rectilinear Lens is suited in every way should only a Doublet Lens be at hand.

The best subjects for instantaneous photography are those in which there is but little contrast. Sea pieces and clouds form objects most suitable for artistic purposes. Trees are rarely rendered satisfactorily, owing to their non-actinic colour.

The exposure, of course, is most rapid; it will often be found of service to have a self-acting system of exposure.

PHOTOGRAPHING THE INTERIORS OF BUILDINGS.

Interiors are often most interesting subjects for the camera. A few hints on the manipulations, &c., when wet plates are used for photographing such subjects, are given.

A collodion which has been iodized long enough to assume a dark straw colour, and to which a grain of bromide of cadmium has been used to each ounce, should be employed.

The plate should be coated as usual; but on immersion in the bath it should be kept in rather violent vertical motion, till all the greasiness has disappeared (which will be in about two minutes). It should then be taken out very slowly, so as to drain completely. Damp blotting-paper should be placed at its back, and the droppings absorbed in the slide by a strip placed at the lower edge. The plate may, by this method, be exposed for a long time (two or three hours) without staining or drying. The rationale of this is as follows:—The plate is kept in the bath long enough to change the iodizers into iodide of silver, whilst the *bromide* of silver is only partially formed. The free nitrate of silver left on the plate is absorbed by the bromizers to complete the change. This prevents the crystallization of the nitrate of silver on the film. The *nitrates* of cadmium, &c., formed, being very deliquescent, retain sufficient moisture to prevent the film drying.

The exposure for an interior can rarely be too long. The

same rule holds good as in ordinary wet-plate photography, viz., expose for the detail in the shadows.

If the sun shines into the windows of the building, the light may advantageously be used, by the use of a looking glass or tin reflector. Those parts in the deepest shadows are those to be illuminated by reflected light. The reflector should always be kept moving about, otherwise an opaque patch will be produced on the negative. Magnesium wire may be burnt in one of Solomon's lamps, to take the place of the sunlight, the same method of procedure being adopted. When a window through which white light is pouring has to be included in the picture, a yellow cloth or blind should be placed over it till the exposure is nearly complete. This prevents halation or blurring.

No. 3 Developer (page 19) should be used, the contrasts between the high lights and deep shadows being *usually* extremely marked.

Intensification is rarely necessary; if it be, the ordinary formulæ are recommended.

It may happen, no matter what care is taken, that markings like slug tracks and oyster shells show with development. These may be caused by using too strong a bath, and also by the drying of the film. Generally they may be obliterated by brushing a fine tuft of cotton wool over the defective spots, either when the film is damp or dry. The latter condition is the safer.

The removal of the markings should, in all cases, precede intensification, as the silver deposited on them by means of the intensifier would be brushed off. This would leave the negative intensified at all parts except on those from which the deposits had been brushed.

Another method, that has been suggested by Mr. Jabez Hughes, is to wash the plates after sensitizing, and after exposure to re-dip them.

The plate, after having been fully sensitized, is placed in a dish of distilled water, and washed till all greasiness disappears. It is then drained, and placed in the slide, with blotting-paper at the back. After exposure, the plate is re-dipped in the bath for at least a minute, when it is developed in the usual manner.

Another method is to wash the plate thoroughly after sensitizing, and float over it any of the given preservatives for dry processes, and develop by the alkaline or gelatino-iron development.

COPYING PLANS, ENGRAVING, ETC.

A most important branch of photography is the copying of plans, sketches, &c. The greatest care should be exercised in the selection of lens and chemicals for the operation, success depending mainly upon them.

No single lens should be used, owing to the curvature given to the marginal straight lines. This confines the choice to the landscape, doublet, and triplet, and to portrait combinations. Of all the doublets, the most satisfactory is Dallmeyer's rapid rectilinear. With it there is no distortion; the reflecting surfaces are fewer in number than in the triplet combination, and therefore it is to be preferred. The triplet seems to have a flatter field; in bright weather, therefore, when there is plenty of actinic light, it may be used with advantage. The triplet and doublet mentioned may be considered, *par excellence*, the copying lenses. Portrait combinations also answer; the general objection to them, however, is that the image is so concave as to be out of focus at the margin, unless one of large diameter be used. Dallmeyer's D lenses have less of this objection. With a large stop they answer for portraits, whilst with a smaller one they answer for copying purposes. No. 6 D lens, by the above maker, will answer for copying plans on an 18 × 15 plate. If a lens of this size be not at hand, the rapid rectilinear or triplet (for 18 × 15) may be substituted.

If the plan have to be reduced by photography with the aid of a portrait combination, it is preferable to have the front lens next the plan to be copied; if it have to be enlarged, the combination should be inverted, and the back lens placed in front.

Unless a special camera be employed, the rendering the image of the plan, &c., to be copied of a particular size, entails considerable labour in shifting the board on which the plan, &c., should be fixed.

The following mode of making the plan parallel to the focussing screen answers well. On the centre of the board on which the drawing, &c., is to be fixed, a small mirror may be temporarily fixed. This latter should be strictly parallel to the surface of the board. The point corresponding to the centre of the lens should be accurately marked on the ground glass. On the lens itself an open cap should be fitted, furnished with two

cross threads, intersecting on the prolongation of the axis of the lens. The image of these cross threads will be reflected by the mirror, and should be focussed. The board should then be tilted or slewed round till the image of their intersection coincides with the point marked on the ground glass.

The board will now be parallel to the ground glass; the mirror being removed, the drawing may be fixed on to it, and focussed as usual. A neat stand for the board will readily suggest itself, by which it may be moved parallel to the position thus fixed, so that the distance necessary to give the exact size required may be attained.

The mirror may be let in flush with the board, thus obviating the necessity of its removal for fixing up the drawing.

A direct light, coming in an horizontal direction, is generally to be preferred for copying, as the texture of the paper is hidden by it. If a vertical light be used, the shadows of the irregularities on the surface of the paper, being copied, may mar the purity of the whites. Should the plan be shaded in flat tint, it may be necessary to copy it in direct sunlight, as indian ink and sepia, and some other colours, are of such a non-actinic nature as to make but slight impression on the sensitive film. For similar reasons, plans or engravings on paper which, through age or other causes, have turned yellow, should be copied, if possible, in a similar light.

The light for copying oil pictures should come from the direction in which the light has been supposed to come in the picture itself. A painter "loads"* his canvas in such a manner as to give the best effect to his picture when viewed in that particular light.

For copying pictures in plain black and white, a simple iodized collodion is recommended by many skilful photographers. In practice it has been found that a bromo-iodized collodion yielding intense negatives answers well for ordinary work. The addition of a grain or two of pyroxyline (or, better still, papyroxyline) which has been washed in dilute ammonia will often cause a limpid collodion to become fit for copying purposes. The alkaline reaction in collodion gives intensity,

* Loading is a term applied to the different thicknesses of paint that are applied to a picture. In certain positions the edges of the ridges formed by the paint reflect the light, and give great purity to the high lights.

and this is further increased by the addition of the pyroxyline. If a painting, either in monochrome or colours, have to be reproduced, the ordinary bromo-iodized collodion is recommended.

The bath should be free from any impurity, and may be of the ordinary strength.

For plans or line drawings, developers Nos. 1 and 5 (pages 18 and 20) are recommended. The iron may be used even weaker than in No. 1, and may be as follows :—

Protosulphate of iron	5 grains
Glacial acetic acid	10 minims
Alcohol	*quant. suf.*
Water	1 ounce.

With a simple iodized collodion, pyrogallic acid may be resorted to as a developer. Should this be decided upon, half the acetic acid given (formula, page 18) should be added, otherwise the deposit may become too crystalline in form. In winter, or when the light is weak, the iron developer should invariably be employed.

For ordinary paintings a twenty-grain developer may be taken as a standard solution; a stronger or weaker one may be necessary, according as great or little contrast is desired.

Negatives of plans drawn in lines should never be fully developed, and they should be slightly under-exposed. When the reduction on the whites has taken place, the developer should be washed off and the negative fixed. By this method deposit on the lines is avoided.

The negatives will require intensification. In rare instances the simple application of the iodine solution (page 22), followed by the pyrogallic intensifier, will suffice. Should this, however, not give sufficient density, either Nos. 6, 7, 8, or 9 (page 23) may be tried in addition. The last three should be again followed (after the negative has been well washed) by 10, 11, or 12. If No. 6 be used the negative should be placed in the sunlight for two or three days, when it will be found that the whites have become perfectly non-actinic.

With No. 8 it is convenient to immerse the negative in the solution contained in a flat dish, and it should be left till the film has acquired a white appearance by transmitted and reflected light. If, after Nos. 10, 11, or 12 shall have been applied, the

whites are not sufficiently dense, pyrogallic acid intensifiers may be applied, and after intensification proceeded with as before.

It requires considerable practice in manipulation to prevent (1st), a deposit forming on the lines from the pyrogallic acid intensification, or (2nd) the lines from becoming filled up by the deposit of mercury and silver.

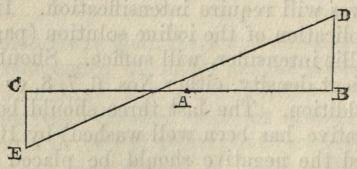
It is safer, after using a solution of mercury, to let the negative dry spontaneously. Rapid drying is apt to cause the film to split.

The ordinary procedure of wet-plate intensification should be carried out in copying paintings.

For copying, it is useful to know the equivalent focus of a lens, as by it the distance of a plan, &c., from the lens may be known.

The equivalent focus of a lens is a term applied to a compound lens. It is the focus of parallel rays entering the lens. It is termed "equivalent" from being compared with a single lens that would produce the same sized image at the same distance from the object.

Measure a distance of (say) one hundred and fifty feet away from some fixed point, and place a rod at one extremity. From this point measure a line exactly at right-angles to the first of some forty feet in length, and place another rod at its other end. Now place the front of the camera exactly over the starting point of the first line and level it, the lens being in the direction of the first line. Having marked a central vertical line on the ground glass with a pencil, focus the first rod accurately, so



as to fall on the pencil line on the ground glass. Take a picture of the two rods in the ordinary way, and measure back as accurately as practicable the distance of the centre of the ground glass from the starting point, and also the distance apart of the two images of the rods (at their base) upon the negative.

Suppose the first measured line, AB, to be 149′; BD, the second line, to be 35′; AC to be 1′; and EC, the distance apart of the two images, to be 3″, F being the point where DE cuts CB.

Then BD+CE : CB :: CE : CF, which is the equivalent focal distance.

Here, CB=150 ft. BD+CE=35·25′ ft. CE=·25 ft.

$$\therefore \text{CF}=\frac{150\times\cdot25}{35\cdot25}=1.063 \text{ ft.}$$

This gives the equivalent focal distance, which is the distance of the ground glass from the optical centre. Hving taken the thickness of the ground glass previously, the distance may be set off from its smooth side on to the brass work of the lens by a pair of calipers. This point (the optical centre) having once been obtained, its position should be marked on the brass work, and from it all measurements should be calculated. This method is *very nearly* mathematically accurate. Were the distance taken of shorter length than those given, an appreciable error might be found. At the distance given the rays of light entering the lens from the rod are virtually parallel, and thus fulfil the necessary conditions. It must also be remarked that the distance AB being so great in comparison with AC as that any slight error in the back measurement will affect the result by an inappreciable quantity, CE should be measured most accurately from the negative. The mean of a series of trials should be taken.

Having obtained the equivalent focal distance of the lens, the respective distance of the object and ground glass from the optical centre can be obtained by the following formula:—

$$v=\frac{f(n+1)}{n} \text{ and } u=nv$$

where v is the distance of the focussing screen, u that of object from the optical centre, n being the linear reduction, or enlargement.

The following is a table of enlargement or reduction for lenses with certain equivalent focal distances:—

Equivalent Focus of Lens.	Reduction.	Enlargement or Reduction. 1	2	3	4	5	6	Enlargement.	Remarks.
6″	u	12	18	24	30	36	42	v	v = distance of image on ground glass, and u = distance of the object from the centre.
	v	12	9	8	$7\frac{1}{2}$	$7\frac{1}{5}$	7	u	
$6\frac{1}{2}$	u	13	$19\frac{1}{2}$	26	$32\frac{1}{2}$	39	$45\frac{1}{2}$	v	
	v	13	$9\frac{3}{4}$	$8\frac{2}{3}$	$8\frac{1}{8}$	$7\frac{4}{5}$	$7\frac{7}{12}$	u	
7	u	14	21	28	35	42	49	v	
	v	14	$10\frac{1}{2}$	$9\frac{1}{3}$	$8\frac{3}{4}$	$8\frac{2}{5}$	$8\frac{1}{6}$	u	
$7\frac{1}{2}$	u	15	$22\frac{1}{2}$	30	$37\frac{1}{2}$	45	$52\frac{1}{2}$	v	
	v	15	$11\frac{1}{4}$	10	$9\frac{3}{8}$	9	$8\frac{2}{4}$	u	
8	u	16	24	32	40	48	56	v	
	v	16	12	$10\frac{2}{3}$	10	$9\frac{5}{6}$	$9\frac{1}{6}$	u	
$8\frac{1}{2}$	u	17	$25\frac{1}{2}$	34	$42\frac{1}{2}$	51	$59\frac{1}{2}$	v	
	v	17	$12\frac{3}{4}$	$11\frac{1}{3}$	$10\frac{5}{8}$	$10\frac{1}{5}$	$9\frac{7}{12}$	u	
9	u	18	27	36	45	54	63	v	
	v	18	$13\frac{1}{2}$	12	$11\frac{1}{4}$	$10\frac{7}{8}$	$10\frac{1}{2}$	u	
$9\frac{1}{2}$	u	19	$28\frac{1}{2}$	38	$47\frac{1}{2}$	57	$66\frac{1}{2}$	v	
	v	19	$14\frac{1}{4}$	$12\frac{2}{3}$	$11\frac{7}{8}$	$11\frac{2}{5}$	$11\frac{1}{12}$	u	
10	u	20	30	40	50	60	70	v	
	v	20	15	$13\frac{1}{3}$	$12\frac{1}{2}$	12	$11\frac{2}{3}$	u	
$10\frac{1}{2}$	u	21	$31\frac{1}{2}$	42	$52\frac{1}{2}$	63	$73\frac{1}{2}$	v	
	v	21	$15\frac{2}{3}$	14	$13\frac{1}{8}$	$12\frac{3}{5}$	$12\frac{3}{4}$	u	
11	u	22	33	44	55	66	77	v	
	v	22	$16\frac{1}{2}$	$14\frac{2}{3}$	$13\frac{3}{4}$	$13\frac{1}{3}$	$12\frac{5}{6}$	u	
$11\frac{1}{2}$	u	23	$34\frac{1}{2}$	46	$57\frac{1}{2}$	69	$80\frac{1}{2}$	v	
	v	23	$17\frac{1}{4}$	$15\frac{1}{3}$	$14\frac{3}{8}$	$13\frac{4}{5}$	$13\frac{5}{12}$	u	
12	u	24	36	48	60	72	84	v	
	v	24	18	16	15	$14\frac{2}{5}$	14	u	

Applying this table to an example:—Suppose the equivalent focal distance of the lens to be $9\frac{1}{2}$″, and that it is desired to find

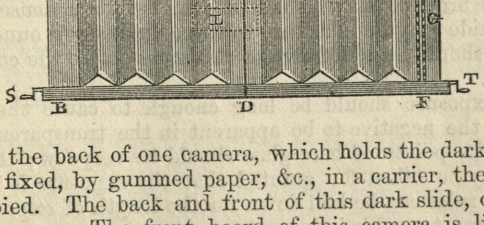
the distance at which the ground glass and the object are to be placed, to give an enlargement of four times linear (*i.e.*, sixteen times in area). In the first column find $9\frac{1}{2}$, and trace it horizontally till it reaches the column headed 4. Then $47\frac{1}{2}''$ will be the distance of the screen from the optical centre of the lens; and $11\frac{7}{8}$ the distance of the object from the same point.

Where any lens is used for copying, it is useful to find out the *exact* equivalent focus, and to make a table similar to this for it. By so doing, if a scale be marked on the base-board of the camera, the plan or object to be enlarged or reduced may be placed in proper position at once, as may also the ground glass.

PRODUCTION OF TRANSPARENCIES.

The production of positive transparencies on glass from a negative is necessary, as a rule, for the multiplication of negatives reversed or otherwise. The following are modes of production.

First, by a camera. It is primarily necessary to have a camera which can give a great length for focussing, and also a sliding front or hood, with a front board containing a carrier for the negative to be copied. With a short focus lens almost any camera may be adapted for this purpose, as there is nothing in the construction of a hood which is beyond the skill of any village carpenter. Two cameras placed front to front on a steady base will answer every purpose, the dark slide of one being opened, and used as a carrier for the negative to be copied. The accompanying rough sketch gives an idea of what is required:—



AB is the back of one camera, which holds the dark slide, in which is fixed, by gummed paper, &c., in a carrier, the negative to be copied. The back and front of this dark slide, of course, are kept open. The front board of this camera is lifted out,

whilst the lens is being screwed into the front board of the other camera. The distance between B and D can be regulated by the screw S, whilst the distance between D and F is regulated by the screw T. The ground glass C is in EF, and the focussing takes place at F.

The negative from which the transparency is to be made is placed in the corner at AB, and the base-boards of the two cameras (or that of the copying camera) are supported on a table the plane of which can be made to slope at any practical angle. The axis of the camera should be so tilted that the negative can be seen through the lens with a clear sky behind it, or else a looking-glass may be made to reflect the sky.

Mr. Elwell, of Weston-super-Mare, has adopted a mode of obtaining transparencies by using an opening (through an outside wall) in his dark room to hold the negative, and placing a table level with it to hold his camera. A mirror placed at about 45° with the horizon, and covered over with plate glass as a protection from dust and rain, reflects the clear light of the sky through the negative.

If attention have been paid to find the equivalent focus of the lens used, as given in the chapter on lenses, it will be found that the distance at which to place AB from CD will be attained after a couple of trials. The negative should be focussed very sharply.

The negative for a brilliant transparency should be slightly less dense, if possible, than for good printing. It is, however, by no means to be inferred that a negative of even great density cannot be copied; but only to be understood that this class will give the finest results.

The use of a highly-bromized collodion is to be recommended. For ordinary printing-negatives the addition of one grain of bromide to the ounce will suffice; for a negative of the weak type the bromide may be omitted; whilst for a dense negative the bromide may be added up to three grains per ounce. The bromide should be added five or six hours before the collodion is required.

The exposure should be long enough to cause the *minutest* detail in the negative to be apparent in the transparency. On drying, the points of bare glass should be very few; if it be not so, it may be taken for granted that the exposure is too short. No fixed rules can be laid down for the length of exposure; the operator must use his judgment.

The development is carried on with a very weak developer, the strength varying with the density of the negative to be reproduced; the denser the negative, the stronger the developer should be. For a negative of medium density the following may be used :—

Protosulphate of iron	5 grains
Glacial acetic acid	5 minims
Alcohol	*quant suf.*
Water	1 ounce

For a *very* dense negative the ordinary 20-grain iron developer (page 19) may be used. Should there be too much contrast, add more bromide to the collodion, and use a stronger developer; if too little, diminish the quantity of bromide, and use the weak developer. Intensification may be carried on to such a point that on looking through the glass the *deepest* shadow appears nearly opaque.

The transparencies should be fixed with hyposulphite of soda (see page 78), in order that the delicate details may not be eaten away in the slightest degree.

The ordinary colour given by silver is not an agreeable one, and it is generally necessary to tone the image. This may be effected by a platinum salt, a gold salt, or an iridium salt, or by a mixture of any or all of them. The formulæ are as follow :—

1.—Ten-grain solution of bichloride of platinum (page 153)	1 ounce
Hydrochloric acid	1 drachm
Water	1 ounce
2.—Terchloride of gold	1 grain
Hydrochloric acid	6 minims
Water	2 drachms
3.—Chloride of iridium	10 grains
Hydrochloric acid	½ drachm
Water	1 ounce

If a mixture in equal quantities by measure of Nos. 1 and 2 be taken and flowed over the plate, a pleasing tone will be given. When toning with gold a pink deposit is apt to form on the transparent portions, which spoils the effect. The platinum solution by itself will give rather an inky colour.

Transparencies may also be made by placing dry plates in contact with the negative, in any ordinary printing frame. The exposure may be made by opening the windows in the dark room for a very short time (varying from half a second to twenty seconds in dull weather), or it may be given by the light from a strong gas jet. With an Argand burner of twenty-candle power, and with the frame six inches from it, an exposure of about six minutes will be required. Other dry plates will answer, though not so satisfactorily as the above. With gum-gallic plates the colour given by development (if double the quantity of gelatine solution be added to the iron) will be generally of a warm black, which needs no toning.

The collodio-chloride process may also be adopted. A glass plate should be albumenized round the edges, as for dry processes, and is coated with the collodio-chloride (page 93). When dry, the film is fumed with ammonia, by holding it over the mouth of a bottle, and moving it till the entire surface has received the vapour. The plate is now brought into contact with the negative in a pressure-frame. If strips of paper be gummed on to the corners of each plate, it may be examined without danger during printing; otherwise, a tolerable guess may be made at the time necessary to expose it by opening half the frame and looking through the two plates. It will be found that the print on the collodio-chloride is not possessed of sufficient vigour. The necessary amount is given by flooding it with:—

Gallic acid	75 grains
Acetate of lead	50 ,,
Acetic acid	2 drachms
Water	20 ounces.

To this a few drops of a twenty-grain solution of nitrate of silver should be added. When the intensity* is sufficient, the plate is washed, and then fixed with weak hyposulphite of soda. The image may be toned as given above.

Another method of producing transparencies is by carbon printing. The gelatine is transferred to glass (which has had a slight trace of waxing solution rubbed over it) instead of to the

* The intensity increases on drying, therefore a certain allowance must be made.

zinc plate (page 98). The picture in this case will be reversed,* which is an advantage in mounting, as the ground glass protects the film.

In mounting a transparency some translucent substance must be placed behind it. Ground glass is usually employed, the rough surface being placed on the outside. With all except the carbon transparencies, the following may be substituted :—

Flake gelatine...	2 ounces
Glycerine	¼ ounce
Water	6 ounces.

The gelatine should be allowed to soak in cold water till it is thoroughly swelled, and then dissolved by placing the vessel containing it in hot water. Just previous to use, sufficient of the solution should be taken, and to the above amount two ounces of new milk be added, heated to 90° F. ; the whole to be stirred together well with a glass rod, and sufficient of the mixture poured from a measure or jug through fine muslin to cover the plate, which must have been *accurately* levelled. It should be allowed to set, and then be dried spontaneously in a warm room. If the transparency be reversed the gelatine should be poured on the film side. When thoroughly dried (in the last case) the film may be stripped off, and it will carry the collodion pellicle with it. The picture may be cut out and bent to any form after varnishing ; for instance, lamp-shades may be composed of a set of prints thus produced.

If two hundred grains of oxide of zinc replace the milk, we have Mr. Burgess's Eburneum process. The solution, with the oxide added, should be kept warm, and allowed to stand six or eight hours before being allowed to solidify. The frothy top-layer, and the bottom layer containing the course particles, are removed, and the solution is to be re-melted and poured on the plate as above. About four ounces of solution should cover a 12 by 10 plate.

REPRODUCTION OF NEGATIVES.

In all cases (excepting when the reproduced negative is to be reversed) a rather thin transparency must first be made. Any

* In producing transparencies in the camera, the same reversal may be effected by turning the film-side of the negative away from the lens. The glass must be absolutely free from flaws to give a perfect result.

of the methods given in the last article may be adopted. The transparency is treated in the same way as the negative. From a carbon transparency, however, a negative cannot be made by contact printing, as, being raised in the high lights, the surface of the dry plate or collodio-chloride film is prevented from being in contact with the picture. It will be noticed that enlarged negatives can be produced either by making an enlarged transparency, or by enlarging the negative from it in the camera. In all cases of enlargement the camera must be employed for one or the other. The one exceptional case where a negative can be reproduced without a preliminary transparency is by the collodio-bromide process. The negative should be placed in the carrier in front of the lens, with the film side outwards. If a dry collodio-bromide plate be used, it is exposed and developed by the alkaline method, the development being carried on to such a point that the metallic (or oxide of) silver is apparent, in the deepest shades, by reflected light at the back of the plate.

A trace of fog is not objectionable, if the negative to be copied be very dense. *The plate is not fixed,* but dilute nitric acid (one of acid to one of water answers) is poured over the film. This dissolves away the reduced silver, and leaves a negative image formed of bromide of silver. The plate is well washed, and a very dilute solution of ammonia is floated over the film to neutralize any acid. After washing thoroughly, the plate is taken into the light, and developed with the alkaline developer once more. This reduces the bromide of silver to the metallic state, and gives the required negative. If too weak, the image may be intensified with pyrogallic acid and silver, as for a wet plate.

The same procedure is taken if wet bromide of silver be used. A plate is treated with collodion containing eight grains to the ounce of bromide of cadmium, ammonium, or a proportion of each. It is sensitized in an eighty-grain bath for ten minutes, or the forty-grain bath for twenty minutes. After thorough washing, any one of the preservative solutions given for dry plates is flowed over it, and the exposure takes place whilst it is wet. The ordinary alkaline development is then proceeded with, and the remaining operations are as above described.

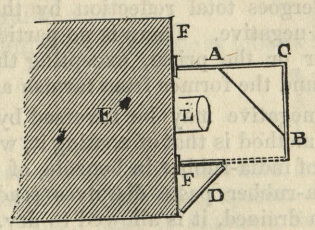
REVERSED NEGATIVES.

For photo-mechanical printing, and single transfer carbon printing, reversed negatives are essential. Their production

may be divided into three classes: 1st, those negatives taken reversed; 2nd, negatives reversed by transferring a negative taken in the ordinary way; 3rd, reproduction from other negatives.

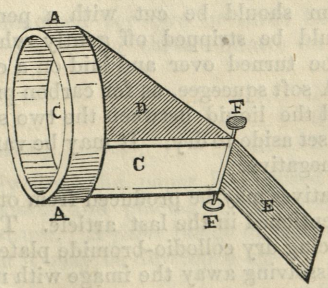
In the first case, the negative should be taken by means of a reflector, from a flat plate or glass silvered externally.

The accompanying sketch gives an idea of what is required.



E is the camera, L the lens, A, C, B, D is the section of a hood round which is fitted a flange (F F) which can be screwed into the camera. A B is a mirror, as above described, which is placed at an angle of 45° with the axis of the lens, and so placed that the centre of the mirror is its continuation; D is a small door, which can be opened or shut at pleasure. The object to be photographed is reflected from A B to the lens, and a little consideration will show that the image on the focussing-screen will give a reversed negative.

The mode of silvering the mirrors is given at page 158.



Another plan of obtaining a reversed image is by using a right-angled prism fitted on to the lens.

A A is a flange that fits on the lens, taking the place of the cap; C C is a right-angled glass prism, whose breadth is equal to or greater than the diameter of the front glass of the lens. All the surfaces are enclosed in brass mounting, excepting C C, care being taken that the surface enclosing the right angle is not in contact with the surface of the glass; E is a shutter for exposure; F F, screws for clamping E. The image undergoes total reflection by the prism, and this gives a reversed negative. There is no particular rule for using either the mirror or the prism, excepting that both should be free from dust, and the former from tarnish as well.

An ordinary negative may be reversed by transferring the film. The best method is that of coating it, whilst unvarnished, with a solution of india-rubber in benzole, of the consistency of collodion* (india-rubber paste dissolves readily in this menstruum). When drained, it is allowed to dry. Transfer collodion, made as follows, should then be flowed over the surface, and allowed to dry thoroughly:—

Ether	5 ounces
Alcohol ·805	10 ,,
Castor oil	¼ ounce
Pyroxyline	¼ ,,

The plate should then be immersed in cold water for a few minutes, or until the film seems to become loose. Should this not take place in reasonable time, one ounce of sulphuric acid may be added to each gallon of water, which will aid the detachment. The film should be cut with a penknife round the edges, and should be stripped off gently whilst in the water. It should then be turned over and laid on a clean plate whilst still floating. A soft squeegee, as for carbon printing, may then be used to expel the liquid between the two surfaces, and the plate should be set aside to dry. It may be varnished and used as an ordinary negative.

Reversed negatives may be produced from other negatives by the processes mentioned in the last article. They may also be produced by placing dry collodio-bromide plates *in contact* with the negatives, dissolving away the image with nitric acid before fixing, and proceeding as before shown.

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* About one grain to two grains to the ounce.

PAPER ENLARGEMENTS BY DEVELOPMENT.

Albumenized paper should be sensitized in the following bath :—

Nitrate of silver	40 grains
Glacial acetic acid	30 minims
Water	1 ounce

and developed with gallic acid.

The gallic acid solution may be made as follows :—

Gallic acid	3 grains
Acetic acid	5 minims
Water	1 ounce.

The paper is immersed in a dish of this fluid, and the development takes place rapidly if properly exposed. Remembering that it is a positive print that is required, the purity of the whites must be preserved, and the development stopped before any deposit takes place on the highest light. When properly developed the print should be taken from the developing dish, and *well washed.* Any of the ordinary toning baths will give it an agreeable tone. It should be fixed, as usual, with hyposulphite of soda and water.

Plain paper may be salted with—

Chloride of sodium	100 grains
Hydrochloric acid	6 minims
Water	12 ounces

The paper is immersed for two or three hours, and then dried. It is then floated for three minutes on a solution of silver :—

Nitrate of silver	1 ounce
Citric acid	8 grains
Water (distilled)	8 ounces

When moderately dry, the paper is exposed as before, by pinning it on a board, and placing it, after focussing, in the camera or its substitute. A *faint* image of the negative should be visible, and then it may be developed by—

Pyrogallic acid	2 grains
Citric acid	1 grain
Water	1 ounce

Sufficient of this must be taken to well cover the paper (which should previously have been stretched on a glass plate, by turning the edges underneath it); in the flow no stoppage must be allowed whilst covering the surface. As soon as the proper contrast is obtained, the paper is well washed, and, if necessary, toned. The prints are finally fixed in—

Hyposulphite of soda...	1 ounce
Water	16 ounces.

They are kept in this till the high lights lose any trace of colour; they are then withdrawn from the solution, and washed in the ordinary manner, as described at page 90.

SELECT PROCESSES.

TO PURIFY WATER FOR PHOTOGRAPHIC PURPOSES.

The importance of using chemically fit water in photography is not to be over-rated. When distilled water cannot be obtained, resort must be had to purifying it to the best of our ability. The water should be roughly tested, to see what impurities it contains.

First add a drop of nitric acid to (say) one ounce of water; warm, and add a few drops of a solution of sulphocyanide of potassium. A red colouration will show the presence of iron sufficient to be injurious in making up a silver bath. Next add to a fresh portion a little ammonia and oxalate of ammonia: a faint precipitate will show lime present to the extent of about six grains per gallon. This may be neglected. If more than a trace of precipitate be apparent, the water must be purified from the lime. Next boil the water. A precipitate will show that the lime is present as a bi-carbonate; if not, it is present as a sulphate. Magnesia is much less common in water than lime, and is present generally as sulphate—Epsom salts. Supposing all be present, and it is necessary to render them innocuous, we must proceed as follows:—First the water must be boiled, to get rid of carbonic acid and to precipitate the carbonate from the bi-carbonate of lime; this will leave about two grains per gallon of the carbonate of lime in solution. Next add ammonia till the water is slightly alkaline to test-paper. This will precipitate any iron present (probably present as carbonate), leaving

carbonate of ammonia and a little free ammonia in solution. Boil the water again till all the ammonia is expelled. Next add a grain to the ounce of water of nitrate of silver, and place it in a blue or white glass bottle in the sun. This will precipitate the carbonates and chlorides present, and also the organic matter. Next add a few drops of a solution of nitrate of baryta to precipitate the sulphuric acid that may be present in the sulphates, and filter. The water thus purified will make an excellent bath water. If water be only required for washing dry plates, &c., it should be boiled and passed through a charcoal filter, when it will be fit for use.

Rain-water should be passed twice through a charcoal filter to render it fit for use, that is, supposing it has been collected from the roofs of houses.

Water collected from snow is generally quite free from every hurtful impurity.

THE PREPARATION OF OXIDE OF SILVER.

If to a solution of nitrate of silver a solution of potash be added, a precipitate will be formed. This is the oxide of silver. The potash should be added till no further precipitation takes place. The oxide should be allowed to settle, when the supernatant fluid should be decanted off (a syphon arrangement is very convenient), and fresh distilled water added to it. This, in its turn, after the oxide has been well stirred, should be decanted off. The operation should be repeated five or six times, until a drop of the water evaporated to dryness on a clean piece of platinum foil leave no residue. The chemical reaction is as follows :—

Nitrate of Silver.		Potash.		Oxide of Silver.		Nitrate of Potash.		Water.
AgO,NO_5	+	KO,HO	=	AgO	+	KO,NO_5	+	HO
$[2AgNO_3$	+	$2KHO$	=	Ag_2O	+	$2K,NO_3$	+	$H_2O]$

The chief use of oxide of silver is to neutralize a bath in which there is free acid, the nitric acid forming with it a fresh nitrate of silver.

From this it is apparent that the oxide should be added till there is a slight deposit left.

The oxide of silver is very slightly soluble in water, hence on adding it to a bath solution it may be necessary to add a few

drops of a dilute solution of nitric acid (one part of acid to ten of water).

TO PURIFY A BATH SOLUTION BY BOILING DOWN.

The bath should be placed in an evaporating dish, and be evaporated down to small bulk (say to ten ounces, from an eighty-ounce bath). To this add half-an-ounce of pure nitric acid, and continue the evaporation to dryness, not to fusion. The nitric acid destroys all organic matter present. The nitrate should be re-dissolved in ten ounces of water, and be evaporated again to dryness, when it will be found that it is fit for making up to strength, all excess of acid being dissipated.

Boiling down a bath rids it of the alcohol and organic matter, but leaves the nitrates of cadmium, &c., unchanged. When surcharged with these latter, the silver should be precipitated.

NEW BATHS FROM OLD.

First Method.—Dilute the bath to twice its bulk, and filter out the iodide of silver which will be precipitated.

In the filtered bath solution place strips of copper or copper wire, and leave them undisturbed for twenty-four hours. This will throw down the silver in a metallic state, leaving the nitrates of copper and cadmium potassium in solution. Take two or three drops of the *solution*, and test for the absence of silver by adding a little solution of common salt to them. If no white precipitate appear, the conversion into metallic silver is complete. Carefully decant the supernatant fluid, and withdraw all the copper visible; wash the silver in three or four changes of water until the blue colour due to the nitrate of copper is absent; all the other salts will be washed away with the nitrate of copper. Place the metallic silver in a large porcelain dish, and add *gradually* one drachm of pure nitric acid (1·36, the strength of the British Pharmacopœia) to every 150 grains of nitrate of silver (this can be estimated by the argentometer) in the original bath solution. The silver will gradually dissolve, but will be much aided by the application of heat. The solution will now have a greenish colour, from small particles of copper which have fallen from the original wires or strips, and which have become coated over with metallic silver. These small particles of copper will be dissolved by the nitric acid, and will form nitrate of copper. Boil down the solution to small bulk—

till it begins to spurt. This will free it of any great excess of nitric acid. Next add distilled water to it till it has a slightly larger bulk than it had before boiling down. Next add the oxide of silver, little by little, till the blue or greenish colour has entirely disappeared. This will precipitate the oxide of copper from the nitrate of copper, setting free the nitric acid, which, in its turn, will combine with the oxide of silver. The copper will fall as a black powder mixed with any excess of oxide of silver there may be. Take one or two drops of the solution in a measure, and add a drachm of water, and then add ammonia to it till the precipitate first formed is re-dissolved. If no blue colour is apparent, the substitution of the silver for the copper is complete; if not, more oxide of silver must be added till the desired end is attained. Distilled water must next be added till the strength of the bath is that required. This can be tested by the argentometer. An emulsion of iodide of silver *may* here appear. If it do, no matter. When the solution is filtered the bath is fit for use, being chemically pure, neutral, and charged to a proper extent with iodide of silver.

Second Method.—Dilute and filter the bath as in the first method, and place in the solution strips of zinc. The silver will precipitate, as with the copper; small particles of zinc will also fall with the silver, and must be got rid of. This may be done by two methods—either by dilute hydrochloric acid, or dilute sulphuric acid (one part of acid to twelve parts of water). The silver is collected from the solution either by filtration or decantation, and is well washed. It is then placed in a porcelain dish, and is boiled with the dilute acid. This dissolves the zinc, and only slightly attacks the silver. The mass is thrown on the filter, and washed well with boiling distilled water. If sulphuric acid have been used, this washing dissolves out any sulphate of silver which may have been formed. The silver is dissolved up by nitric acid, as in the first method. If hydrochloric acid have been used, there will remain a little chloride of silver, which will be filtered out.

TO MAKE NITRATE OF SILVER.

Silver coins are mostly alloyed with tin or copper. In both cases the coin should be dissolved in nitric acid diluted with twice its bulk of water. If tin be present there will be an insoluble residue left of binoxide of tin. The solution should

be evaporated down to dryness, re-dissolved in water, filtered, and again evaporated to dryness. It will then be fit for making up a bath. If copper be present, the solution must be treated as given in the last article, where the oxide of silver is substituted for oxide of copper.

AN EASY TEST FOR THE AMOUNT OF NITRATE OF SILVER IN A SOLUTION.

Besides the test given for testing the amount of nitrate of silver in solution given at page 42, the following may be made use of. Take half an ounce of the solution to be tested, and precipitate the silver as chloride by adding a slight excess of hydrochloric acid. Filter the solution off, and dry the filter paper and the chloride over a water bath. The chloride can then be easily removed from the filter paper, and should be weighed. The weight multiplied by 1·18 will give the amount of fused nitrate of silver, or by 1·29 for the amount of crystallized nitrate of silver.

UTILIZATION OF SILVER RESIDUES.

All paper or solutions in which there is silver should be saved, as it has been proved by experience that from 50 to 75 per cent. of the whole of the silver used can be recovered by rigid adherence to the careful storing of "wastes."

1. All prints should be trimmed, if practicable, before toning and fixing; in all cases these clippings should be collected. When a good basketfull of them is collected, these, together with the bits of blotting-paper attached to the bottom end of sensitized paper during drying, and that used for the draining of plates, should be burnt in a stove, and the ashes collected.* These ashes will naturally occupy but a small space in comparison with the paper itself. Care should be taken that the draught from the fire is not strong enough to carry up the ashes.

2. All washing from prints, water used in the preparation of dry plates, old baths, developing solutions (after use), and old toning baths should be placed in a tub, and common salt added. This will form chloride of silver with the nitrate.

3. The old hyposulphite baths used in printing, and the solutions of cyanide of potassium or hyposulphite of soda used for fixing the negatives, should be placed in another tub. To this

* In large establishments the films from rejected negatives may be added.

the sulphide of potassium of commerce may be added, or else a stream of sulphuretted hydrogen passed through it till no more precipitation takes place. Sulphide of silver is thus formed.

4. To (1) nitric acid may be added, and the ashes boiled in it till no more silver is extracted by it. The solution of nitrate of silver thus produced is filtered off through fine muslin, and put aside for further treatment.

5. The ashes may still contain chloride of silver. This may be dissolved out by adding a solution of hyposulphite of soda, and adding the filtrate No. 3.

6. The solution from No. 4 may next be evaporated to dryness, and crystals of nitrate of silver be produced, as given in page 149, or else common salt may be added, and the precipitate added to No. 2.

7. No. 2, after thoroughly drying, may be reduced to metallic silver in a reducing crucible* by addition of two parts of carbonate of soda and a little borax to one of chloride of the silver. These should be well mixed together, and placed in the covered crucible in a coke fire, and gradually heated. After a time, on lifting off the cover, it will be found that the silver is reduced to a metallic state. After all conflagration has finished, the crucible should be heated to a white heat for a quarter of an hour. The molten silver should be turned out into an iron pan, and immersed in a pail of water. Wash repeatedly till nothing but the pure silver remains.

8. Another method may be adopted, which is to place the chloride of silver in contact with sheet zinc or iron, covering it with acidulated water or oil of vitriol. The zinc or iron is converted into chloride, and the silver is deposited in a spongey mass.

9. The chloride may also be dissolved in hyposulphite of soda, and added to 3.

The hyposulphite of silver, having been reduced to the sulphide by the addition of the sulphide of potassium, is placed in a crucible and subjected to a white heat; the sulphur is driven off, and the silver remains behind.

10. A last method is that of treating the whole of the residues as hyposulphite. A sheet of zinc is placed in the tub, and the silver is precipitated in a metallic state. The supernatant liquid is syphoned off, and replenished from the other waste solution.

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* The crucible should be of Stourbridge clay.

When the amount of silver deposited is sufficient, it is filtered out through fine calico and collected. After thorough washing it may be treated with nitric acid to form nitrate of silver, or else be melted in a crucible with borax to form an ingot. If the plan be adopted of forming nitrate of silver, the small amount of gold present will be left behind as a grey powder. This, after being well washed, may be treated with nitro-muriatic acid, as given below, and re-converted into terchloride. There will always be a certain amount of sulphate of silver formed from the action of the nitric acid on the sulphur deposited with the silver.

TO MAKE TERCHLORIDE OF GOLD [AU CL_3].

Place a half-sovereign (which may contain silver as well as copper) in a convenient vessel; pour on it half a drachm of nitric acid, and mix with it two-and-a-half drachms of hydrochloric acid; digest at a gentle heat, but do not boil, or probably the chlorine will be driven off. At the expiration of a few hours add a similar quantity of the acids. Probably this will be sufficient to dissolve all the gold. If not, add acid the third time; all will have been dissolved by this, excepting, perhaps, a trace of silver, which will have been deposited by the excess of hydrochloric acid as chloride of silver. If a precipitate should have been formed, filter it out, and wash the filter paper well with distilled water. Take a filtered solution of sulphate of iron (eight parts water to one of iron) acidulated with a few drops of hydrochloric acid, and add the gold solution to it; the iron will cause the gold alone to deposit as metallic gold, leaving the copper in solution. By adding the gold solution to the iron the precipitate is not so fine as if added *vice versa*. Let the gold settle, and pour off the liquid; add water, and drain again, and so on till no acid is left, testing the washings by litmus paper. Take the metallic gold which has been precipitated, re-dissolve in the acids as before, evaporate to dryness on a water bath that is at a heat not exceeding 212° F. The resulting substance is the terchloride of gold. To be kept in crystals this should be placed in glass tubes hermetically sealed. For non-commercial purposes, it may be dissolved in water (one drachm for a grain of gold is convenient). Ten grains of gold dissolved yield 15·4 grains of the salt. Hence if ten grains have been dissolved, 15·4 drachms of water must be added to give the above strength.

TO OBTAIN ALCOHOL FROM SPIRITS OF WINE.

Take pure carbonate of lime, and burn it thoroughly in a crucible, expelling all the carbonic acid. This product will be quicklime. Add this to the spirit of wine to be rectified, and leave it in a tightly-corked bottle for three or four days. The quicklime will absorb the water, leaving the alcohol nearly anhydrous; the alcohol, with the quicklime, may now be transferred to a glass flask and be distilled over. (See also next Article.)

TESTING FOR THE AMOUNT OF WATER IN ALCOHOL.

Take a small quantity of chloroform and pour it into a graduated test tube. Add to it a given quantity of the alcohol to be tested. Shake up both well together. On settling, the water will have combined with the chloroform, and the difference in volume may be read off the test tube.

Another method is to add an *excess* of dry carbonate of potash to a given quantity, and then to read off the amount of fluid left. This obtains an account of the insolubility of the carbonate in alcohol, and its affinity for water.

Anhydrous alcohol may be obtained quickly by this method, taking care that the carbonate of potash is dry, and well shaken up. The supernatant fluid is then syphoned off, and is of the best specific quality obtainable.

TESTING FOR METHYLATED ALCOHOL.

If a small quantity of caustic potash be added to alcohol suspected of being methylated, the presence of the impurity will be indicated by a brownish tint being given to the liquid.

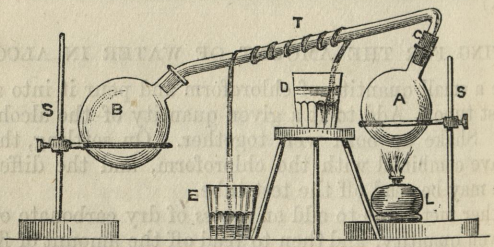
PREPARATION OF BICHLORIDE OF PLATINUM ($Pt\ Cl_2$).

Take any old scraps of platinum foil or wire, and having cleaned them with boiling nitric acid, place them in a porcelain dish containing aqua regia (four parts of hydrochloric to one of nitric acid). By the aid of heat this will cause a solution of bichloride of platinum to be formed. The solution is evaporated nearly to dryness, or until it becomes viscous. It is then re-dissolved in water, and evaporated to the same state once more. For photographic purposes, this may be re-dissolved again in distilled

water of the strength of one grain of the bichloride to one drachm of water. It should be remembered that every ten grains of platinum yield 17·2 grains of the bichloride; hence, with every ten grains of platinum dissolved, 17·2 drachms of water must be added to make it of the above strength.

TO MAKE A STILL FOR DISTILLING ALCOHOL.

The accompanying diagram shows the method for forming a



rough still, but one which is perfectly adapted for small distillation. A and B are two Florence flasks, supported, as shown, by two supports; S S earring rings. In the neck of A is fitted a perforated cork, C. A piece of quarter-inch soft glass tubing is bent in a common gas flame, and fitted into the cork, the long arm sloping slightly downwards. Two tumblers, D and E, are placed in position as shown. D is filled with water, and from it is carried a length of tow. This is wrapped round and round the tubing, and the other end is allowed to hang over E. Capillary attraction will cause the water to be carried round the tubing by the tow. This will ensure the latter always being cooled. Into the flask A is poured the liquid to be distilled, and a spirit lamp, L, is placed below it. The vapour passes into the tube T, where it is condensed, and passes into B. This plan will be found of use for distilling alcohol, collecting the solvents from old collodion.

TO RECOVER ETHER AND ALCOHOL FROM OLD COLLODION.

Add to the collodion a little potash to neutralize all acidity, and also a small piece of metallic zinc. This will leave the free iodine and bromine as iodide and bromide.

The solution may now be distilled over as given on the previous page, taking the precaution to fit a cork (through which a safety tube should pass to the bottom of the flask) into the bottle into which the condensed vapours pass.* The solvents may be used for fresh pyroxyline.

TO PREPARE ALBUMEN FOR SUBSTRATUM.

Place the albumen in a mortar with a little silica or fine *white* sand, and grind it till it is perfectly even. Next add the water required. This method may be substituted for that given at page 56.

DENSE COLLODION.

A formula for dense collodion is here given, as it may be of use in dry plates—

Ether...	½ ounce
Alcohol	½ ,,
Pyroxyline	7 grains
Iodide of ammonium	6 ,,
Bromide of cadmium	3 ,,

TO CLEAN THE HANDS FROM SILVER AND IRON STAINS.

Take hydrochloric acid and dilute it to half its strength. Pour a quarter of an ounce of this on the hands, and rub well in till the stains disappear. Iron stains may still remain of a greenish tint. *Rinse the hands*, and apply a little dilute solution of ammonia or potash. The hands will be found free from stains. This method avoids the use of cyanide of potassium or hyposulphite of soda. Chlorides of the alkalies are sometimes recommended in lieu of the hydrochloric acid. They are not so effective. The hydrochloric acid does not discolour the hands permanently. The alkaline solution in any case restores the tissues to their proper colour. After alkaline development the stains may be got rid of by oxalic acid. In all cases cyanide of potassium will be effective. This should only be used with excessive caution, on account of its poisonous character.

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* The flask should be heated by hot water; if by the naked flame, the ether vapour is given off too energetically.

TO TAKE SILVER AND IRON STAINS, ETC., OUT OF LINEN.

The same procedure as above is effective; iron and silver are converted into chloride, and pyrogallic acid is decomposed by the acid. The iron washes out, and the chloride of silver is afterwards dissolved by the ammonia.

To take stains out of cloth the same method may be tried, but it is rarely completely successful by any method, as the dye will be attacked by the acid; cyanide of potassium applied with soap may be tried, but it often leaves stains caused by the mordant of the dye.

GROUND GLASS.

When the ground glass of the camera has been broken, circumstances sometimes prevent it being replaced by a purchased article. The following method will give a substitute for it:—

Take a piece of glass of the size to be ground. Lay it flat on a board or table, sprinkle the finest emery over the surface, and moisten it. With another small piece of glass grind it smoothly and evenly till a uniform grain is apparent over the whole surface. The finer the emery the finer will be the resulting grain.

TO MIX SOLUTIONS CONTAINING GUM.

It is often necessary to mix solutions containing gum at a short notice. The gum should be pounded to powder in a mortar, and warm water added to it. It is easily filtered through "papier Joseph." On no account should a flask containing undissolved gum be placed over a naked flame, or the gum will then become decomposed. An enamelled glue pot is very useful for preparing gum solutions, the temperature of boiling water being thus never exceeded. Should gum be acid, it may be neutralized with lime-water. Lime-water is formed by placing a piece of burnt lime the size of a nut in a pint of water.

PURIFYING PRINTING BATHS.

The ordinary method of purifying a printing bath from the albuminate formed is to add a small quantity of pure kaolin, then to shake it up and filter. This method answers perfectly, but is rather wasteful.

If the bath be rendered quite neutral to litmus paper, and be placed in the sun, the organic matter is deposited together with the oxide of silver, and the solution rendered pure.

If a small quantity of chloride of sodium (common salt) be added, it will be found, on shaking up the chloride of silver formed, that the organic matter is deposited with the chloride, and can be separated by filtration.

The addition of a carbonate of soda answers equally well, and may be used with advantage. It is generally advisable to have a small quantity of the carbonate of silver at the bottom of the bottle, as by so doing, the neutral condition of the bath is ensured, and the organic matter is continually being deposited.

TO INTENSIFY A NEGATIVE AFTER VARNISHING.

A negative may be rendered more intense after varnishing by adding iodine to the varnish till it assumes a light port wine colour, and re-varnishing with this solution in the ordinary manner.

A SIMPLE METHOD OF ADDING EXTRA BROMIDE TO A COLLODION.

Dissolve eighteen grains of bromide in an ounce of collodion. The addition of a drachm of this to each ounce of the collodion will give (very nearly) an extra two grains of bromide.

TO INTENSIFY A NEGATIVE BY THE ACTION OF LIGHT.

If, after developing, the negative be well washed, and exposed to sunlight till the unaltered iodide assumes a brownish colour, the intensity of the negative will be found to be materially increased.

TO RETOUCH VARNISHED NEGATIVES.

The best vehicle for retouching negatives is blacklead pencil (B answers well). When varnished the negative requires a "tooth" given it to take the pencil. This is best given by taking *very finely powdered* resin, and rubbing it gently over the part required to be retouched. Finely-powdered pumice may be substituted for the resin.

If a negative be varnished without heat, a sufficient tooth will also be given; but great care is required, in re-varnishing it, to preserve the blacklead from running. In this case the second coating of varnish should be applied cold, and the plate be afterwards well heated.

TO REMOVE THE VARNISH FROM A NEGATIVE.

Varnish may be removed from a negative by warming it gently, and applying spirits of wine to its surface *gently*. The spirit must be poured off, the plate re-heated, and a fresh quantity applied as before. This operation must be continued till the varnish appears to be totally dissolved from the surface of the negative. Caustic potash will also remove most varnishes.

CONVENIENT DROPPING BOTTLES.

A convenient dropping-bottle may be formed with any ordinary four or six-ounce bottle by cutting a slot in the cork from end to end, and fixing it in the bottle in the ordinary manner. If this and an ordinary cork be attached to the neck of the bottle by twine, the two may be interchanged as required.

TO TEST FOR IRON IN A FILTER PAPER.

Moisten the filter paper with a drop or two of hydrochloric acid. Then add a drop of ferrocyanide of potassium to the moistened part. A blue stain will show the presence of sufficient iron to be injurious to a bath solution.

TO SILVER GLASS FOR MIRRORS.*

Prepare three standard solutions:—

1.	Nitrate of silver	90 grains
	Distilled water	4 ounces
2.	Potash *(pure)*	1 ounce
	Distilled water	25 ounces
3.	Milk sugar	½ ounce
	Distilled water	5 ounces

Nos. 1 and 2 will keep indefinitely; No. 3 should be prepared immediately before use.

Pour two ounces of No. 1 into a glass vessel capable of holding 35 fluid ounces; add drop by drop (stirring all the time) as much liquor ammonia as will just dissolve up the first precipitate caused by it; add four ounces of No. 2. The new precipitate must be dissolved up once more by ammonia. Add distilled water till the bulk reaches 15 ounces, and add drop by drop some of No. 1, until a grey precipitate is just formed which

* The substance of the article is taken from Browning's "Plea of Reflectors."

does not dissolve after stirring for three minutes. Add fifteen ounces more of distilled water. Set this solution aside to settle, but it must not be filtered.

When all is ready for immersing the mirror, add to the silvering solution two ounces of No. 3. No. 3 may be filtered.

Having secured a piece of perfectly flat plate glass, about six inches by four inches, melt some soft pitch, and having moistened the back of glass with a little turpentine to secure adhesion, run in the water a small quantity of the pitch, and insert a pencil end in it, to which has been secured from the other end a loop of string by which to suspend it. Let the whole rest till cold.

The surface of the plate which is to be silvered is next to be cleaned by nitric acid, rubbing it gently with a brush of cotton wool or the "Blanchard brush." It is then washed well with common water, and finally rinsed with distilled water. The glass is placed in distilled water till the silvering fluid is ready.

In a dish about three inches deep, and slightly larger than the glass, the solution No. 3, and the silvering solutions made of Nos. 1 and 2 and ammonia, should be mixed, and the plate be suspended by the loop in the fluid just so far that the back is not covered. After sixty to ninety minutes the silvering will be complete, and the glass must be removed, and immediately washed thoroughly, and finally rinsed with distilled water. It should then be placed on end, on blotting-paper, and be allowed to dry *perfectly*. When dry the surface is polished by rubbing circularly with a piece of the softest washleather, and finally by the addition of the finest rouge.

The pitch is then separated from the glass by a chisel, and any small particles remaining are removed by scraping and by a little turpentine.

Success in the operation is greatly dependant on not using an excess of ammonia, and on the purity of the distilled water.

HINTS ON APPARATUS.

THE CAMERA.

For out-door and landscape photography the camera should be of the lightest possible make, as far as is compatible with rigidity. That form which is known as "the bellows," with

parallel sides, when properly made, fulfils these requirements better than any other. In it the lens remains fixed, whilst the ground-glass is made to move to attain proper focus. This will be found of great convenience. *Every camera* should have a "swing-back;" that is, the ground-glass should be made to hang plumb when required, supposing the camera to be tilted. For portraiture the same class of camera may be used, though a heavier kind for this purpose is not objectionable; the body may be rigid, in which case focus would generally be obtained by movement of the lens. For hot climates and rough usage brass binding is recommended for the woodwork, and Russia leather for the bellows; cockroaches and white ants will not attack the latter.

For an amateur photographer, $8\frac{1}{2}$ by $6\frac{1}{2}$ is recommended as a suitable size. He can, unaided, conveniently carry this size, together with a dozen dry plates. Care should be taken that the inside of body is coloured of a *dead* black, otherwise reflections on to the plate may occur, giving a hazy appearance on portions of the negative. The mode of testing this instrument will be patent to all; the chief defect to be looked for being a want of coincidence of the rough surface of the ground-glass with the plane of the silver wires which support the sensitized plate in the dark slide. Well seasoned mahogany is the wood most suitable for a camera, and it should be borne in mind that polish gives greater durability to it.

The camera legs should be of such a length as will allow the lens to be raised at least five or six feet high. This rather exceeds the average height of the eye. There are various portable folding legs extant for rigidity and convenience; though rather heavy, there are none better than Paget's pattern, to be got at Meagher's, 21, Southampton Row, London.

LENSES.

For landscape photography a single lens gives the most brilliant picture. It is more rapid than any other, as the loss of light from reflection by the surfaces is the least possible. For architectural subjects a doublet or triplet lens is necessary, as the first-named lens distorts marginal lines. For a complete outfit it is well to have four lenses:—1, An ordinary single lens; 2, a wide-angle single lens; 3, a doublet lens; and 4, a wide-angle doublet. If only one lens can be provided, 3 should

be chosen in preference to the others. For stereoscopic work the same applies. For portraiture a portrait doublet should invariably be used. By consulting a catalogue of some well-known maker all information necessary for guiding the choice will be found.

English made lenses are to be recommended in preference to those of foreign make. They are more expensive, but are better finished, and are always achromatically corrected; that is, the chemical and visual foci are made to coincide.

BATHS.

Porcelain baths answer well till the glaze gets cracked; they must then be put aside, as contamination of the bath solution may result. Glass baths in a wooden case with water-tight top are to be most recommended, as the solution can be inspected from time to time, also any accumulated dirt on the inside will be immediately noticed. One precaution should be observed in selecting glass baths, viz., to ascertain that the wooden case does not fit tightly on to the glass. The bottom of the case and its top should be padded with thick felt, to prevent breakage by any casual jar. Ebonite is too brittle and too much injured by climate, whilst gutta-percha is generally too impure a material to be substituted for glass.

DIPPERS.

Ebonite dippers answer in a temperate climate, and are not liable to break. A hook at the back to catch the edge of the bath, which just prevents it touching the bottom of the bath, is an advantage. Any deposit thrown down is thus undisturbed. Makeshift dippers may be manufactured from a long strip of glass, cementing a smaller strip on to it. Silver wire dippers, perhaps, are the best, as they prevent an accumulation of the bath solution at the back of the plate.

DEVELOPING CUPS.

Glass developing cups are far superior to any other, as they can be kept clean, and the amount of solution in them can be accurately seen, which is not the case with ebonite cups. In the field it is useful to have a couple of the latter ready at hand in case of accidents with the former. For plates up to 10 × 8, the children's small tumblers, sold for about a penny, answer every purpose, and they are difficult to break.

PNEUMATIC PLATE-HOLDERS.

There is no better plate-holder than the india-rubber globe pattern. It is convenient to have the globe enclosed in a cylindrical box open at the lower end.

NON-ACTINIC GLASS.

The orange or red glass used for the dark room or tent should be tested. If a prism, such as a drop from a chandelier, be at hand, this is easily done. The eye should be brought close to one edge of it, and white light from a window be allowed to pass to it through the glass to be tested; if the violet, blue, and green rays be cut off, the glass is non-actinic. A practical test is to lay a piece of sensitized paper beneath the glass and expose it to sunlight for half an hour; if the paper remain very nearly white the glass will answer.

THE DARK TENT.

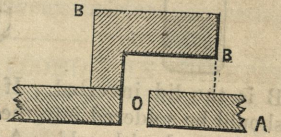
There are a considerable number of dark tents which are capital for field work. A box tent is handy, as it will carry all the chemicals necessary for a day's photography. Rouch's pattern—modified by the writer—is worth a trial, as it has a few improvements which add much to the comfort of manipulation. A tent should be of such a size and weight that it can be conveniently carried by a man. For hand carriage it should not weigh more than 25 lbs., including chemicals. Stillman's manipulating box is handy, and also the knapsack tent, for small pictures. When a tent is erected it should, if possible, be placed in the shade. The window should invariably be turned away from direct sunlight. The tent should be tested by placing in it a sensitized plate for a couple of minutes, whilst the window is darkened. Should the plate remain unaltered by development it may be taken for granted that the tent is fit for use. The window glass should be tested as above.

DRYING-BOX FOR DRY PLATES.

To the photographer who works with home-made dry plates a perfect drying-box is a *sine qua non*. It may be taken for granted that the larger the box the more even will be the drying of the plates, and consequently the better chance of perfection in the negative.

An ordinary cupboard may be converted. The shelves at

the back edge should be pierced with holes close together, or an interval left between them and the back of the cupboard. About two and a-half inches from the back small tumblers (such as described for developing cups, page 16) should be let into the shelf, the rim projecting about half an inch above the shelf itself. Small strips of glass should then be fastened round the cupboard, at such a height that when the corners of the plates which are to be dried rest in the tumblers, the opposite corners should rest against them. Ventilation should be secured by boring holes at the top and bottom, covering them with strips containing L-shaped holes. The accompanying diagram shows the form. A A is the top of the cupboard; B B, the strip of wood screwed on to cover the aperture O. The inside of the L pieces and the side of O should be blackened, to prevent any reflection of light. If hot-water or hot-air pipes can be passed through the cupboard, it will aid the rapidity of drying. In this case, over the pipes, and at a distance of six inches from them, should be placed a sheet of perforated zinc. This will equalize the distribution of the heat to a great extent.



FUNNELS.

Ribbed glass funnels will be found better than those made with smooth glass, as the air which is displaced can, with the former, find a ready exit. Gutta-percha funnels should be used with caution, as it is impossible to ascertain if they are clean.

EVAPORATING DISHES.

The best evaporating dish is made of platinum or silver.* A substitute for the latter metal can be made by using one thickly electro-plated. They last a long time, and are not a quarter the price. Berlin porcelain may be used. Dishes made of this should be at least six inches in diameter to use with comfort. A metal dish enables a solution to be evaporated to dryness without burning, or driving off the water of crystallization.

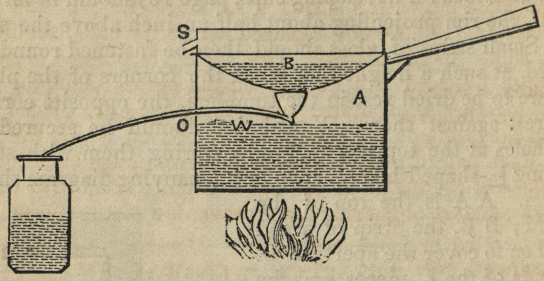
STILLS.

A still should be of a portable character. It should be ascertained that the worm of the condenser is not made of lead or any lead compound. The top of the still should be of such

* When a silver dish is used, no nitric acid must be added.

a shape that any water which may be projected upwards during ebullition shall not be able to travel down to the worm.

The following is a makeshift, which is in imitation of a well-known Indian contrivance. A is a saucepan of large size;



B is the lid inverted. If a tinsmith be at hand, a spout, S, should be soldered into the lid, that the heated water in B may be changed with cold. A small hole is bored in the side of the same pan at O, into which is fitted a tobacco pipe as shown in the figure. The surface of the water, W, is below the pipe. When the water boils the steam is condensed on B, trickles down to the tobacco pipe, and is collected at the other end of it. The first pint of water distilled should be rejected, lest it be contaminated in any way.

DISHES.

Porcelain dishes are recommended in preference to any other kind. It is easily seen if they be clean, and they are easily scoured out after use. Ebonite dishes may be used for hypo-sulphite. They should be constantly cleaned from a sulphur deposit which forms on the bottom.

DRAINING BOXES.

A draining box which opens at the top and bottom is handy for outdoor work. For economy of space each pair of grooves should be capable of holding two plates back to back.

DRY PLATE BOXES.

To store dry plates, resort may be had to the plan of separating each one from the other by two strips of cardboard or thick paper bent zig-zag (as a hem is prepared for stitching), one at each end of the plate. Between each fold is placed a dry plate; the whole bundle should be bound round with twine, and

wrapped in non-actinic coloured or opaque paper. It is necessary, however, when the parcel is broken into, to have some mode of storing the plates. This is best done by using a grooved box with a removable lid. The lid should slide into grooves and lock; an inner loose lid, with a spring attached to its top, and strips of *unvulcanized* india-rubber placed across its ends, should rest on the edges of the plates. The spring is pressed down on the upper lid, and this presses on the plates, clamping them tightly together in position; two other strips are placed similarly on the inside of the bottom of the box on which the plates rest. Each pair of grooves should hold two plates back to back. The whole of the inside of the box is usually lined with tinfoil; this allows dust to be got rid of, and prevents moisture permeating.

QUANTITY OF ABSOLUTE ALCOHOL IN DILUTED ALCOHOL OF DIFFERENT SPECIFIC GRAVITIES.

S G at 60° F.		Percentage of alcohol.	S G at 60° F.		Percentage of alcohol.
·8956	...	60	·8228	...	90
·8840	...	65	·8089	...	95
·8721	...	70	·8061	...	96
·8603	...	75	·8031	...	97
·8483	...	80	·8001	...	98
·8357	...	85	·7938	...	100

TABLE OF THE SYMBOLS AND ATOMIC WEIGHTS OF THE MOST COMMON ELEMENTS.

Name.		Old Notation.	New Notation.	Name.		Old Notation.	New Notation.
Aluminium	Al	13·7	27·4	Fluorine	F	19	19
Antimony	Sb	122·0	122·0	Gold	Au	197·0	197·0
Arsenic	As	75	75	Hydrogen	H	1·0	1·0
Barium	Ba	68·5	137	Iodine	I	127	127
Bismuth	Bi	210	210	Iridium	Ir	99	198
Boron	B	11	11	Iron	Fe	28	56
Bromine	Br	80	80	Lead	Pb	103·5	207
Cadmium	Cd	56	112	Lithium	Li	7	7
Calcium	Ca	20	40	Magnesium	Mg	12	24
Carbon	C	6	12	Manganese	Mn	27·5	55
Chlorine	Cl	35·5	35·5	Mercury	Hg	100·0	200
Chromium	Cr	26·1	52·2	Nickel	Ni	29·35	58·7
Cobalt	Co	29·5	59	Nitrogen	N	14	14
Copper	Cu	31·75	63·5	Oxygen	O	8	16

Name.		Old Notation	New Notation.	Name		Old Notation.	New Notation.
Palladium	Pa	53·3	106·6	Silver	Ag	108	108
Phosphorus	P	31	31	Tin	Sn	59	118
Platinum	Pt	98·75	197·5	Uranium	Ur	60	120
Potassium	K	39·1	39·1	Zinc	Zn	32·6	65·2
Selenium	Sc	39·75	79·5	Zirconium	Zr	44·8	89·6

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1 Sovereign weighs ... ... 123·274 grains
1 Shilling ,, ... 87·273 ,,
48 Pence ,, ... 1 lb. avoirdupois
1 Half-penny = 1 inch in diameter

Avoirdupois Weight.

16 Drachms ... ... 1 ounce (=437·5 grains)
16 Ounces ... ... 1 lb. (=7,000 grains)

Troy Weight.

24 Grains ... ... 1 pennyweight
20 pennyweights ... ... 1 ounce
12 ounces ... ... 1 pound

Apothecaries' Weight, Solid Measure.

20 grains ... ... 1 scruple
3 scruples ... ... 1 drachm
8 drachms ... ... 1 ounce
12 ounces ... ... 1 pound

Apothecaries' Fluid Measure.

60 minims ... ... 1 drachm
8 drachms ... ... 1 ounce
16 ounces ... ... 1 pound
20 ounces ... ... 1 pint
8 pints ... ... 1 gallon

French Weights.

1 gramme ... 15·432 grains
Centigramme ... 10 grammes
Kilogramme ... 10 centigrammes (=2·2 lbs. Avoir. nearly)

French Fluid Measure.

1 litre ... ... 35·216 ounces (fluid)
1 centimetre ... ... 17 minims nearly
50 centimetres 1 ounce 6 drachms 5 minims

FRENCH LINEAR MEASURE.

1 mètre ... ... 39·37 inches

Nitrate of silver is sold by avoirdupois weight. All formulæ in the book are to be made up by apothecaries' weight.

KIT THAT MAY BE NECESSARY FOR ONE DAY'S WORK IN THE FIELD.

Camera.
Dark-Slides.
Camera Legs.
Lenses.
Focussing Cloth.
Do. Glass.
Glazier's Diamond.
Circular Spirit Level.
Tent.
Water Bag and Clip.
Tent Legs.
Yellow Silk Handkerchief.
Bath.
Dipper.
Glass Plates.
Plate Boxes.
Funnel.
Filter Paper.
4-oz. Measure.
Cotton Wool.
Chamois Leather.
Diaper Dusters.
Dusting Brush.
Developing Cups.
Plate Holder.
Emery Powder.
Tripoli Powder.
Spirits of Wine.
Bath Solution.
Collodion.
Developer, 10 grs.
Do., 50 ,,
Intensifier, Iron.
Do., Pyrogallic.
Nitrate of Silver Solution, 20 grains.
Cynanide of Potassium.
Iodine Solution.
Tannin and Glycerine Sol.
Glacial Acetic Acid.
Golden Syrup Solution.
Spirit Lamp.
Bottle of Spirit.
Varnish.

ABSTRACT OF STORES REQUIRED FOR PHOTO-LITHOGRAPHY AND ZINCOGRAPHY.

Acid, hydro.	in stoppered bottles.	1 lb.
,, nitric		1 ,,
,, sulph.		1 ,,
Cloths, cheese	...	2
Cotton waste	... ...	
Eraser, metal, with box-wood handle	...	1
,, with sheath	...	1
Galls, bruised	...	1 ,,
Gum-arabic	... ...	½ ,,
Handles, leather, for rollers	... ...	1 pair
Ink, black, in tin	...	1 lb.
Knives, palette	...	2
Millboards (thickest)		10 lbs.
Mullers, zinc	...	2
Oil, olive	... ...	½ pint
Oil, green	... ...	1 ,,
Plates, zinc (according to size of press), No. 10 guage.		

Press, lithographic ...		Stone, pumice ...	4 lbs.
Roller, ordinary ...	1	,, snake	2 ,,
,, smooth ...	1	Stone, litho., fine and free from chalk ...	
Sand moulders ...	¼ bsh.		
Scrapers, box wood, for press	2	Glaze boards	2
Sieve, 120 hole ...	1	Paper, glass... ...	6 shts.
Sponges	2	Phosphorus	1 oz.

ADDENDUM.

Whilst this book was printing, the author was working out a dry process which appeared to give stability, with delicacy of result.

Any ordinary bromo-iodized collodion is used, and the plate coated and sensitized as usual. The plate (which has had a substratum applied) is then washed thoroughly, and the following is applied to the surface:—

Albumen	1 ounce
Bitter ale	1 ,,
Ammonia	½ drachm

The plate is again thoroughly washed, and the following floated over:—

Bitter ale	1 ounce
Pyrogallic acid	1 grain

If the collodion be highly bromized, the addition of one minim of nitric acid to the ounce is recommended.

The detail is brought out by the weak alkaline developer, omitting No. 3 (thin bromide), and intensity is gained by using three grains to the ounce solution of pyrogallic acid, and a drop at a time of—

Nitrate of silver	20 grains
Citric acid	40 ,,
Water	1 ounce

Between the alkaline development and intensifying the plate should be flooded with acetic acid and water (1 to 10), and washed.

The rapidity of all dry plates, particularly of those prepared by the last process, are much improved by the addition of 5 to 10 grains of nitrate of uranium to the ounce of bath solution. The exposure is very short, in a night light, the same as an ordinary plate will be sufficient, particularly if 6-grain pyrogallic acid solution and 2 drops of a 96-grain solution be used in lieu of that given above. No bromide whatever is required.

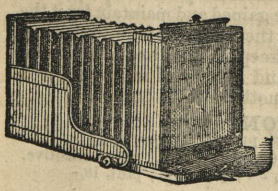
MEAGHER'S NEW FOLDING CAMERA.

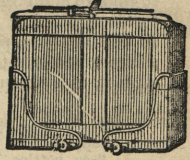
Prize Medals Awarded at London, Edinburgh, Berlin, and Paris.

This CAMERA is similar in construction to the already well-known Binocular Camera, and possesses the following advantages over the existing Landscape or Kinnear form of Camera:—No screws are required for fixing; the focussing is effected from the back by the screw adjustment; the focussing-screen is attached to the camera, and the bellows body is PARALLEL. This will be found of great advantage when using wide-angle lenses. It is available either for the studio or field, the range of focus permitting the use of the shortest-focus stereo lenses, or any of the Wide-angle, Doublet, or View Lenses, also for the C.D.V. or Cabinet Lenses.

"The Cameras of Meagher *deserve especial examination, as well for the perfection of their workmanship as for their perfect adaptation to the purposes for which they are designed.*"—Vide *Report of Jurors*, Class IX., International Exhibition, Paris, 1867, *Illustrated London News*, September 14, 1867, page 298.

"Of the Camera in its most improved form we cannot speak otherwise than in terms of unqualified praise."—Vide *The British Journal of Photography*, March 8, 1867.





These Instruments are now in general use by many of the Leading Professional and Amateur Photographers, to most of whom P. M. is indebted for Letters of Approval and Recommendation, including Messrs. Mayall, H. P. Robinson, Downey Brothers, Hennah and Kent, Hill and Saunders, Elliott and Fry, Thurston Thompson, Blanchard, Parkinson, Duval, Edge, Stuart, Heath, Polyblank, Rolph, Drayson, Hawke, Lucas and Box, Lombardi and Fri, Disderi (Paris), Storey (Milan), Henderson (Montreal), Russell Manners Gordon, Colonel Stuart Wortley, P. Le Neve Foster, Major Russell, Fothergill, Viscount Jocelyn, and many others.

Prices for Pictures.		Swing-back extra.	Brass Binding.	Russia-leather Bellows.
8½ by 6½	£5 16 0	£0 15 0	£1 0 0	£0 18 0
8½ by 8½	6 10 0	0 15 0	1 0 0	0 18 0
10 by 8	6 16 0	1 0 0	1 5 0	1 1 0
10 by 10	7 10 0	1 0 0	1 5 0	1 1 0
12 by 10	8 0 0	1 5 0	1 10 0	1 7 0
12 by 12	8 15 0	1 5 0	1 10 0	1 7 0
15 by 12	10 0 0	1 10 0	2 0 0	1 17 0
15 by 15	11 10 0	1 10 0	2 0 0	1 17 6

The above prices include one Single Back and two Inner Frames.

Double Backs can be adapted to the above. For prices, see page 8 of Catalogue.

From 8½×6½ to 12×12 inclusive the Cameras are fitted with movable Centre Partitions and Loose Inner Frame for 7¼×4½ plates.

☞ If fitted with Swing-back, the Square Camera is recommended.

Extract from a letter from Mr. H. P. ROBINSON.—"I like your New Camera very much; it is very perfect and complete."

"I have never used a Camera which has given me more satisfaction."—Mr. B. J. EDWARDS.

"The more we work with your New Camera and Tent the better we like them."—Messrs. ELLIOTT & FRY.

"I find your New Camera very good. I have worked with it fourteen days in Aden, in a temperature of about 90 deg., and more than six weeks in Upper Egypt and the Desert, in a temperature of 100 deg., and found it answer very well."—Dr. H. VOGEL, December 12, 1868.

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Capable of Adjustment for both Portrait and Landscape Lenses.
The focussing is obtained by an endless screw, or by a rack-and-pinion movement.
These Cameras are made either with a Conical Bellows Body (Kinnear form), or with Parallel Bellows and a Folding Bottom.
The Parallel Body Camera can be had either of the old form or a new arrangement, which will give nearly one-third longer focus, and a double Swing-back, without any increase of price.
Prices, with one Single Back, two Inner Frames, and Focussing Screen.

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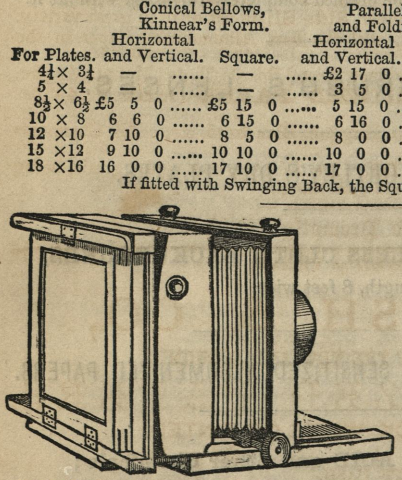
4¼× 3¼	—	—	£2 17 0	£3 7 0	—	—
5 × 4	—	—	3 5 0	3 15 0	—	—
8½× 6½	£5 5 0	£5 15 0	5 15 0	6 10 0	£0 18 0	£1 0 0
10 × 8	6 6 0	6 15 0	6 16 0	7 10 0	1 4 0	1 4 0
12 ×10	7 10 0	8 5 0	8 0 0	8 15 0	1 7 0	1 10 0
15 ×12	9 10 0	10 10 0	10 0 0	11 10 0	1 10 0	2 0 0
18 ×16	16 0 0	17 10 0	17 0 0	19 10 0	1 15 0	2 5 0

If fitted with Swinging Back, the Square Camera is recommended.



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Is adapted for Single or Double Cartes-de-Visite, for Half or Whole-plate Portraits, for the new Cabinet Pictures, and can also be used for Copying. It possesses so many advantages that no other Camera is necessary for ordinary work in the Studio.

Price for 6½ square, with Swing-Back £5 15 0
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Price, for working plates up to 8½ by 6½, complete with Tank, Tray, Spring-clip and Tube, and Tripod Stand			£6 10 0
Ditto	ditto	for plates 10 by 8	7 0 0
Ditto	ditto	,, 12 by 10	7 10 0
Ditto	ditto	,, 15 by 12	8 0 0

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